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SPOKANE REMEDIAL DESIGN/REMEDIAL ACTION PROJECT

PROJECT PLANS
VOLUME 2

COMPLIANCE MONITORING PLAN
DATA MANAGEMENT PLAN

Prepared for

GENERAL ELECTRIC COMPANY

by

BECHTEL ENVIRONMENTAL, INC.

San Francisco, California

December 1993



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GE-SPOKANE REMEDIAL DESIGN/REMEDIAL ACTION PROJECT

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COMPLIANCE MONITORING PLAN

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FOREWORD

This Compliance Monitoring Plan was prepared for General Electric Company (GE) by Bechtel Environmental, Inc. (Bechtel) as one of the GE-Spokane Remedial Design/Remedial Action (RD/RA) Project Plans, as required under the *Consent Decree* (WDOE, 1993b) between GE and the Washington Department of Ecology (WDOE).

According to the Consent Decree:

"Compliance monitoring consists of protection monitoring, performance monitoring, and confirmational monitoring [WAC 173-340-410]. Protection monitoring confirms that human health and the environment are protected during construction and operation and maintenance of the cleanup action. Performance monitoring confirms the cleanup action has attained cleanup standards and any other required performance standard. Confirmational monitoring confirms the long-term effectiveness of the cleanup action after cleanup standards are maintained...Soil sampling is expected to be confirmational monitoring, while ground water efforts should be considered as performance monitoring. Air monitoring during soil treatment is for protection monitoring."

This Compliance Monitoring Plan provides compliance monitoring procedures according to these definitions.

In addition to this foreword, the Compliance Monitoring Plan consists of the following:

- Part 1 - Soil Sampling and Analysis Plan;
- Part 2 - Ground-Water Sampling and Analysis Plan;
- Part 3 - Soil-Gas Sampling and Analysis Plan;
- Part 4 - Quality Assurance Project Plan; and
- References.

The remainder of this foreword provides project background information, gives an overview of planned cleanup activities, and describes the related Project Plans.

Project Background

GE operated an apparatus service shop at East 4323 Mission Avenue in Spokane, Washington, during the period 1961 to 1980 (see Section 2 of the Summary Cleanup Action Planning Report for more information regarding the service shop). Figure 1-1 shows the project site location and Figure 1-2 shows the site layout, including the former facilities, as existed in 1989. Existing site surface features are shown in Figure 1-3.

In 1985, polychlorinated biphenyls (PCBs) were detected in site soils. GE subsequently performed Phase 1, 2, and 3 investigations of PCBs and other constituents in soil and ground water. More information about these investigations is presented in *Bechtel, 1986a; Bechtel, 1986b; Bechtel, 1987; and Golder, 1988*.

In 1989, the site was placed on the National Priorities List (NPL), by the U. S. Environmental Protection Agency (U.S. EPA). Therefore, the site investigations and cleanup are subject to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the Superfund Amendments and Reauthorization Act (SARA). The site is also subject to the State of Washington Model Toxics Control Act (MTCA). The U.S. EPA designated Washington Department of Ecology (WDOE) as the lead regulatory agency for this site.

The area designated as the NPL site includes the GE property and adjacent properties owned by Washington Water Power and Mr. Marvin E. Riley, doing business as Federal Construction Company. Following the change to NPL status, GE entered into an Agreed Order with WDOE. Under the terms of the Agreed Order, GE subsequently performed a two-phase remedial investigation (Phase 4 for soils and other solid materials and Phase 5 for ground water) and a baseline risk assessment (see *Bechtel, 1991a; Everest, 1992; and Golder, 1992b*).

The remedial investigations indicated that PCBs were present in surface soils, in sediments in sumps and other underground structures, and in soils beneath these

structures, including the West Dry Well where steam cleaning effluent was discharged during operation of GE's service shop. Concentrations of PCBs were also detected in ground-water samples collected from wells downgradient of the West Dry Well. Petroleum hydrocarbons, metals and volatile organic compounds (VOCs) were also detected in some soil or ground-water samples. The extent of residual chemicals is described in more detail in Section 2 of the Summary Cleanup Action Planning Report.

During the Phase 4 Remedial Investigation, GE conducted some interim actions, including demolition of the site building and excavation of underground structures and associated soils. These activities are described in the reference *Bechtel, 1991a*.

Since about 1986, GE has been exploring the possible use of in situ vitrification (ISV) for treating the soils containing PCBs at the site. The ISV technology, which is a thermal treatment/immobilization process, is described further in Section 4 of the Soil Treatment Plan. In order to use this technology for treatment of PCB-containing soils at the GE-Spokane site, a Toxic Substances Control Act (TSCA) - required demonstration test must be performed so that the vendor of the technology, Geosafe Corporation (Geosafe), may obtain a TSCA permit for "disposal" of PCBs.

It was planned to conduct the ISV Demonstration Test at the GE-Spokane site in 1991. Shallow soils previously identified as PCB-containing were excavated and placed in five test cells along with soils spiked with imported PCBs and other materials removed during the interim actions described above. The preparations for the ISV Demonstration Test are described more completely in the reference *Bechtel, 1991b*. The planned demonstration test was delayed due to a mishap which occurred during an Operational Acceptance Test of the ISV equipment conducted by Geosafe at its Richland, Washington test site.

Under TSCA, a certificate of disposal must be provided within one year from the date when PCBs are "taken out of service" or removed from their original location. The PCB-spiked soils in one of the ISV test cells are subject to this requirement. The TSCA Section of U.S. EPA Region X was notified that, due to the delay in the planned ISV Demonstration Test, the spiked soils might remain in place for more than one year. U.S. EPA Region X granted an extension of the disposal certification

requirement, with the provision that a plan and schedule for properly disposing of the materials "taken out of service" be submitted by October 1, 1993. A temporary cap was placed over the test cells in November 1991 to prevent infiltration of precipitation into the test cells and periodic site maintenance and inspections have been conducted since that time. The current schedule provided by Geosafe indicates the ISV Demonstration Test may be performed in early 1994.

After completion of the remedial investigations, GE conducted a feasibility study to evaluate remedial alternatives for soil and ground water (*Bechtel, 1992*). The feasibility study concluded that in situ vitrification would be the preferred cleanup action for soils, and institutional controls coupled with ground-water monitoring would be the preferred action for ground water. Contingent remedies were also identified in the feasibility study, for implementation in the event that ISV is not successfully demonstrated or ground-water monitoring and institutional controls are found to be ineffective. The contingent remedies are dechlorination for the soils; and extraction, treatment and discharge to a publicly-owned treatment works for the ground water.

In March 1993, WDOE issued a Cleanup Action Plan for the site (*WDOE, 1993a*). The Cleanup Action Plan specifies PCBs and petroleum hydrocarbons as indicator chemicals for site cleanup and specifies the following cleanup levels:

<u>Medium</u>	<u>PCBs</u>	<u>Petroleum Hydrocarbons</u>
Shallow Soils (≤ 15 ft deep)	10 mg/kg	200 mg/kg
Deep Soils (> 15 ft deep)	60 mg/kg	200 mg/kg
Ground Water	0.1 μ g/L	not applicable

The Cleanup Action Plan specifies that the cleanup action for soils is treatment by vitrification and that the cleanup action for ground water is compliance monitoring and institutional controls; which are the preferred remedies identified in the feasibility study. The Cleanup Action Plan also specifies the same contingent remedies identified in the feasibility study. In-situ stabilization of some of the deep soils (grouting of soils below the West Dry Well from about 30 feet below ground surface to about 10 feet into the saturated zone) will also be performed because it is

unlikely that the ISV technology will be sufficiently developed for treatment of soils at such depths.

The Consent Decree between GE and WDOE (WDOE, 1993b) outlines GE's responsibilities in performing the cleanup, including a specific scope and schedule of activities and deliverables. This document is a required deliverable under the Consent Decree.

Overview of the Cleanup Action

Activities associated with the GE-Spokane cleanup action will include:

- Quarterly ground-water monitoring;
- Performance of treatability tests, including the ISV Demonstration Test, to demonstrate the effectiveness of the selected treatment technologies on site soils;
- Excavation of soils containing chemicals above cleanup levels;
- Volume reduction to mechanically screen cleaned oversized "cobble" materials from fines containing chemicals; and
- Vitrification and/or grouting of soils containing chemicals above cleanup levels.

Sampling and analysis activities to be performed in association with these activities include:

- Ground-water sampling and analysis;
- Soil-gas sampling to determine whether vapor migration through the subsurface occurs during the ISV Demonstration Test;
- Soil sampling to direct excavation and grouting;
- Soil sampling to demonstrate that soils above cleanup levels have been excavated or grouted;

- Soil sampling to confirm cleanliness of the cobble from the volume reduction process;
- Soil sampling to confirm the cleanliness of imported backfill material;
- Sampling of treated soils to confirm the attainment of cleanup levels;
- Onsite analysis of samples; and
- Offsite analysis of samples to confirm onsite laboratory results.

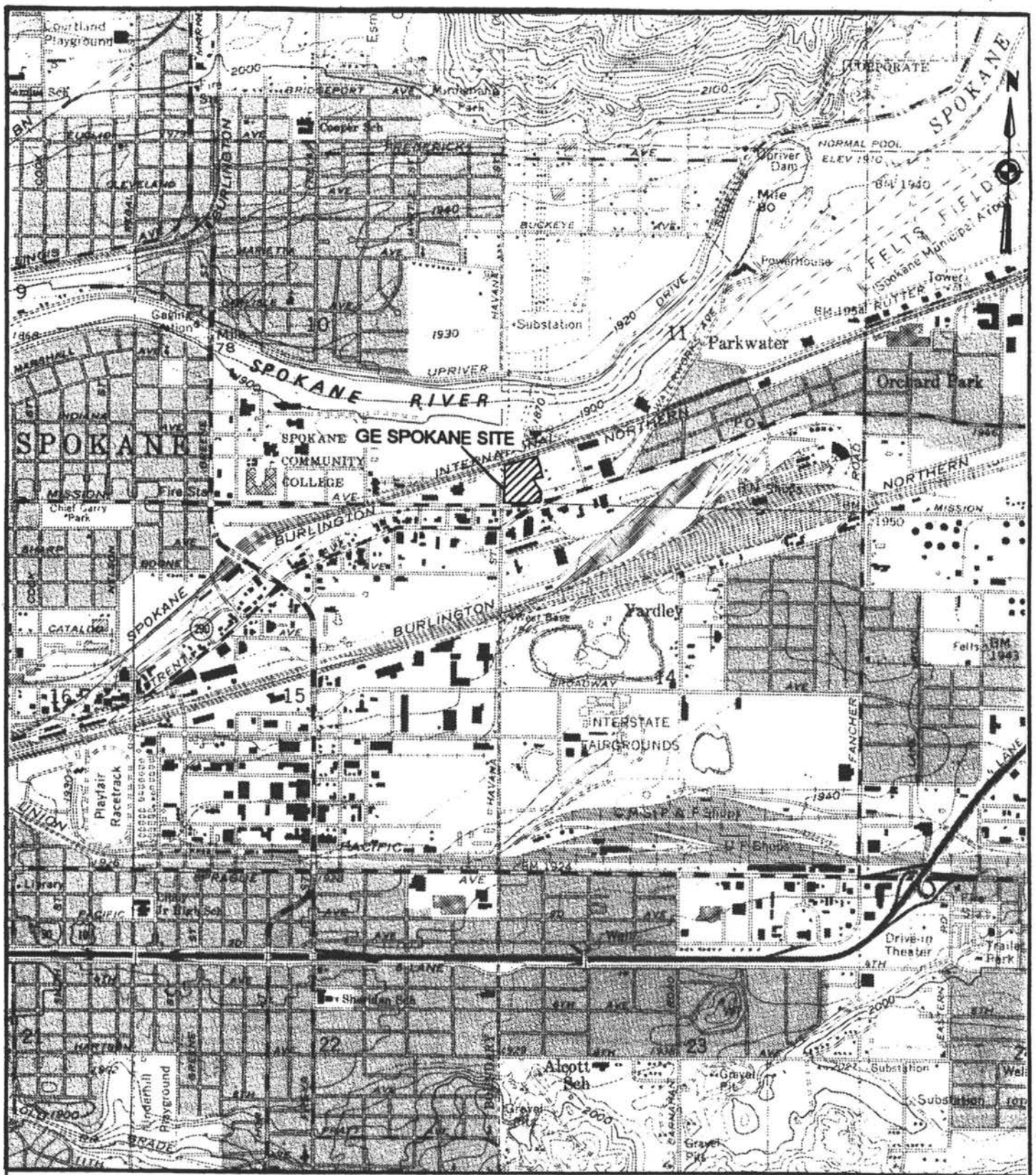
This Compliance Monitoring Plan provides methods and procedures for conducting these sampling and analysis activities.

Related Project Plans

The related Project Plans are listed below:

- The Summary Cleanup Action Planning Report provides an overall description of the project, including organization, schedule and deliverables;
- The Soil Treatment Plan provides details of the planned soil cleanup action;
- The Health and Safety Plan provides procedures for the protection of site workers and includes the required Air Sampling and Analysis Plan;
- The Data Management Plan provides procedures for the statistical evaluation of compliance sampling data; and
- The Investigative and Project Waste Management Plan addresses management of wastes generated from sampling and other project activities.

FIGURES



0 2000 4000
SCALE IN FEET

Bechtel
SAN FRANCISCO

GENERAL ELECTRIC/SPOKANE

SITE LOCATION MAP



Job Number

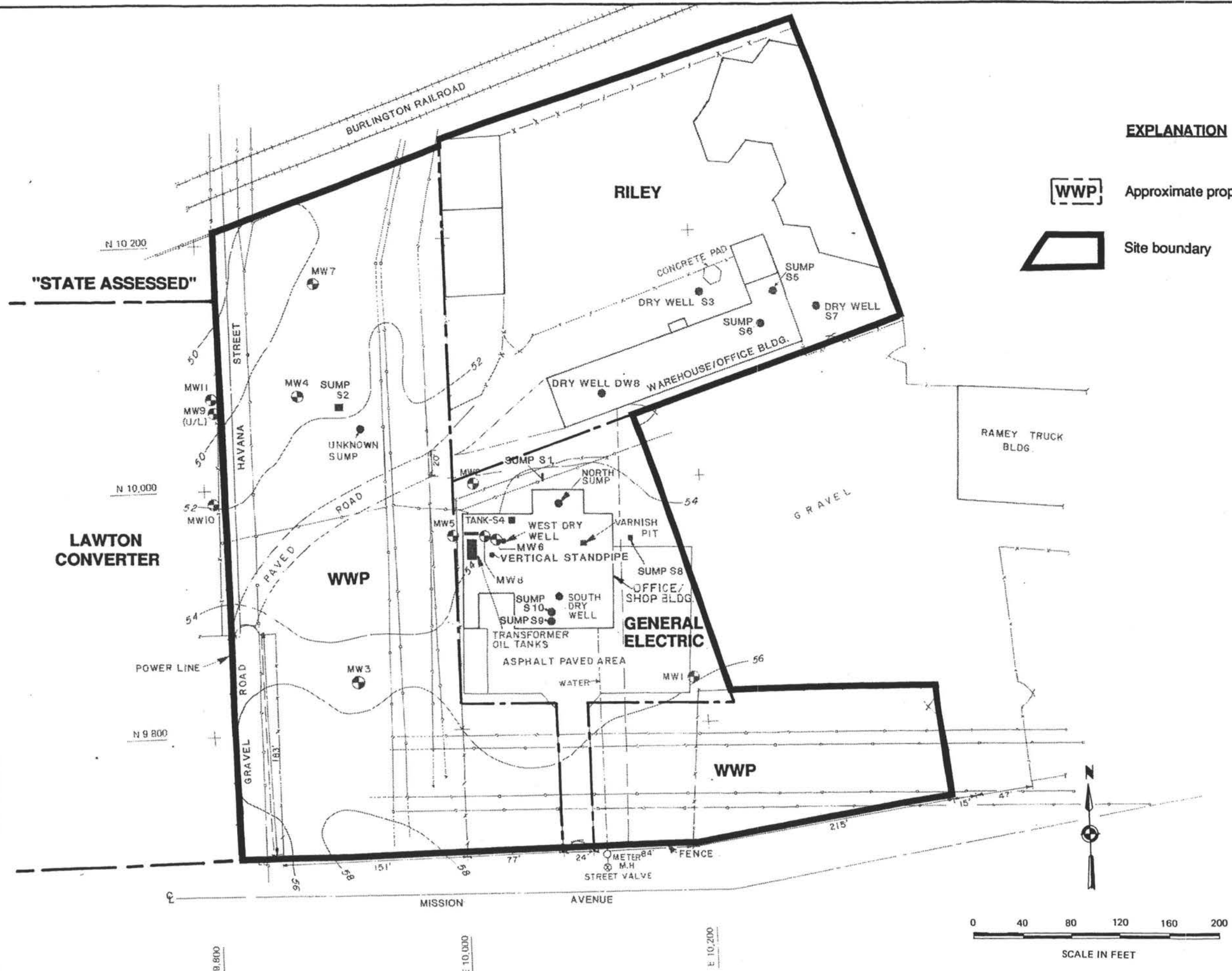
19099

Drawing No.

FIGURE F-1

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CMPF-002-B
8/20/93



EXPLANATION

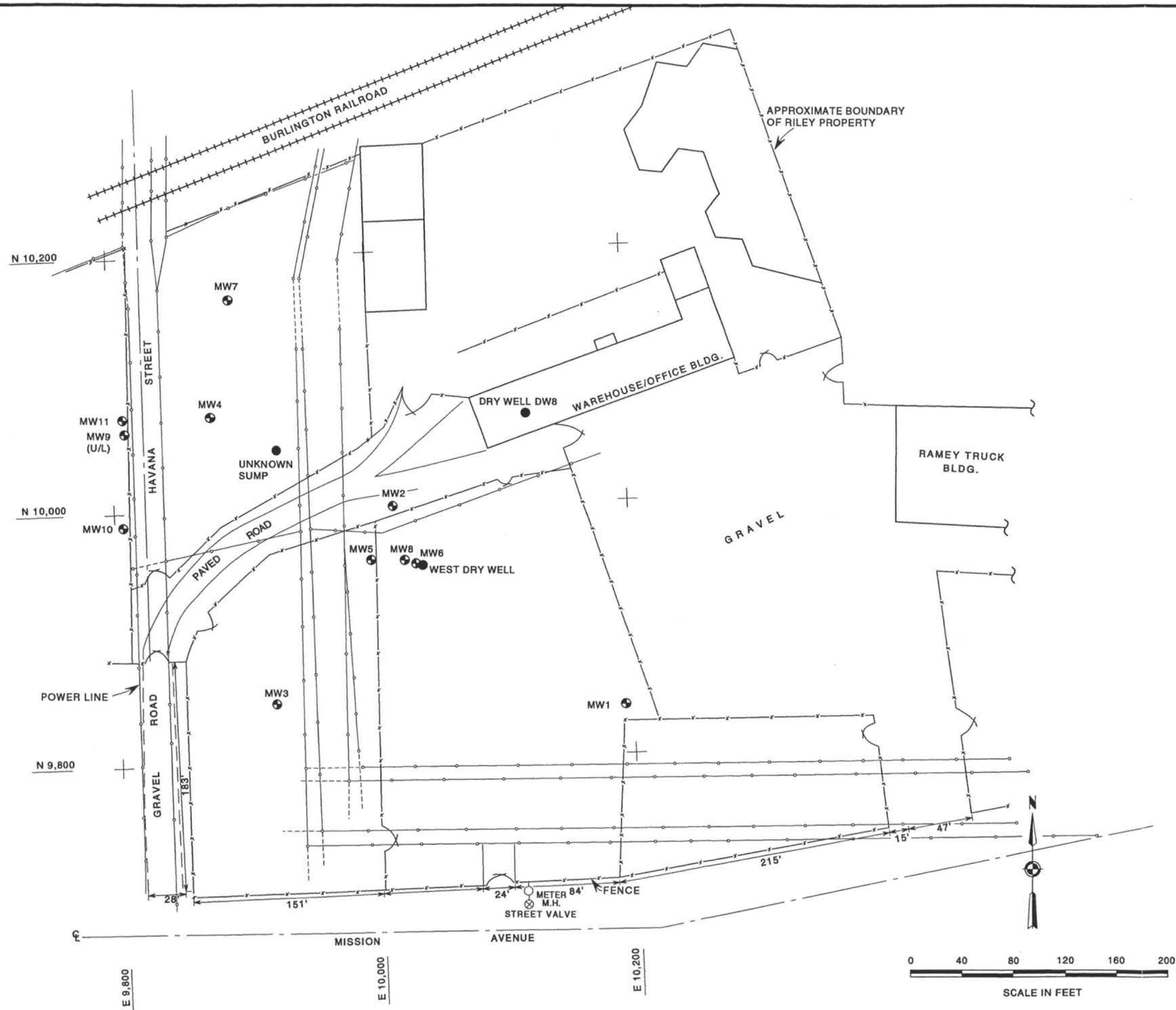


Approximate property boundary and owners



Site boundary

BECHTEL SAN FRANCISCO			
GENERAL ELECTRIC/SPOKANE			
SITE OWNERSHIP AND FORMER FACILITIES			
	JOB No.	DRAWING No.	REV.
	19099	FIGURE F-2	B



Bechtel SAN FRANCISCO			
GENERAL ELECTRIC/SPOKANE			
EXISTING SITE FEATURES			
	Job Number	Drawing No.	Rev.
	19099	FIGURE F-3	A

GE-SPOKANE REMEDIAL DESIGN/REMEDIAL ACTION PROJECT

COMPLIANCE MONITORING PLAN
PART 1

SOIL SAMPLING AND ANALYSIS PLAN

Prepared for
GENERAL ELECTRIC COMPANY

by
BECHTEL ENVIRONMENTAL, INC.
San Francisco, California

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Section 1

INTRODUCTION

This Soil Sampling and Analysis Plan was prepared by Bechtel Environmental, Inc. (Bechtel), for General Electric Company (GE) as Part 1 of the Compliance Monitoring Plan. The Compliance Monitoring Plan is one of the Project Plans for the GE-Spokane Remedial Design/Remedial Action (RD/RA) Project, as required under the *Consent Decree* (WDOE, 1993b) between GE and the Washington Department of Ecology (WDOE). This plan describes the technical objectives and methods for the collection of soil samples which will be used to evaluate compliance with cleanup levels.

Section 2 of this plan presents the sampling objectives. Section 3 describes WDOE access and sampling event planning activities. Section 4 presents an overview of the cleanup action and associated sampling and presents the technical sampling approach, including sampling locations and frequency, for each type of sample. Section 5 describes sample designation and Section 6 discusses sampling methods. Section 7 discusses sample handling, shipping and analysis requirements. Table 1-1 provides a cross-reference indicating where each of the Consent Decree requirements is addressed in this plan.

The RD/RA project is described in the foreword to the Compliance Monitoring Plan. References cited in this plan are provided at the end of the Compliance Monitoring Plan. Quality assurance/quality control procedures for soil sampling and analysis are presented in the Quality Assurance Project Plan, Part 4 of the Compliance Monitoring Plan, and procedures for evaluating compliance are provided in the Data Management Plan.

Section 2

SAMPLING OBJECTIVES

The primary objective of this Soil Sampling and Analysis Plan is to prescribe soil sampling and analysis procedures for the RD/RA project.

The objectives of the soil sampling and analysis are to:

- Provide indicator chemical concentration data to direct the excavation of soil requiring treatment;
- Verify that materials to be placed as backfill do not contain indicator chemicals at concentrations above the cleanup levels;
- Verify that soil treated by vitrification meets the cleanup levels; and
- Verify that grouting has successfully encapsulated soils with concentrations above cleanup levels below 30 feet in the West Dry Well area.

Indicator chemicals and cleanup levels are provided in Section 4.1. To ensure that the sampling and analysis objectives discussed above are met, specific data quality objectives were developed, as discussed in the Quality Assurance Project Plan, Part 4 of the Compliance Monitoring Plan.

Section 3

SAMPLING EVENT PLANNING

This section describes the elements considered for successful planning of the soil cleanup action sampling. These elements include schedule and task assignments for soil sampling activities, access considerations and split sampling opportunities for WDOE, and preparation of Sampling Execution Plans.

3.1 Schedule and Task Assignments

The overall project schedule is provided in Figure 4-1 of the Summary Cleanup Action Planning Report. The samples related to the soil cleanup action (excavation, cobble, backfill, treated soil, and grout placement samples) will be collected during the soil cleanup action scheduled for October 1984 through July 1995.

Supervision and planning of sampling tasks will be assigned to the data management team. The data management team is comprised of the following personnel under the direction of the Project Environmental Scientist: the Project Quality Assurance Manager, the Data Manager, the Data Coordinator, and the Database Manager. Samples will be collected by field sampling personnel. The responsibilities of each of the data management team members are described in Section 1.2 of the Quality Assurance Project Plan. An organization chart showing the relationship of the data management team members is provided in Figure 1-1 of the Quality Assurance Project Plan. The data management team will be involved in all phases of project planning that affect data acquisition, including development of this Soil Sampling and Analysis Plan.

3.2 WDOE Access and Split Sampling Opportunities

Access to the site will be provided to WDOE during normal working hours for split sampling, inspections, etc. The WDOE Project Coordinator should provide 24 hours notice to Bechtel to obtain access.

Written advance notice of each sampling activity will be sent by Bechtel to the WDOE Project Coordinator at least seven days before the commencement of field work. If split samples are requested by WDOE (for audit purposes), other regulatory agencies, or other concerned party, the following is the procedure for providing the split samples:

- 1) The party requesting the split sample(s) must notify Bechtel prior to split sample collection.
- 2) The number of samples collected at a single sampling point will be multiplied by the required number of split samples.
- 3) The sample(s) will be placed in separate containers provided by the requestor and all remaining handling (including labeling, packing, shipping, and analysis) will be the responsibility of the party requesting the split sample(s).
- 4) Collection of the split samples will be documented in the sample logbook.
- 5) The field sampling personnel will receive a receipt from the party requesting the split sample(s).

3.3 Sampling Execution Plans

Prior to the beginning of any sampling event, the Project Environmental Scientist will coordinate with the field sampling personnel and data management team to create a Sampling Execution Plan. The purpose of the Sampling Execution Plan is to ensure that all field sampling and data management personnel have a clear understanding of what each sampling event entails. The Sampling Execution Plan

will consist of a table showing the number of samples, sampling areas or locations, sample identification numbers, constituents to be analyzed, sample containers/preservatives, all associated quality control samples required, and the anticipated dates of sampling and reporting of results, as based on the procedures specified herein. The Sampling Execution Plan, and any deviations from the Sampling Execution Plan, including sampling and analysis requests outside the original scope of work, will be approved by the Project Manager.

Each round of sampling will be initiated by Bechtel by providing a copy of the Sampling Execution Plan to the analytical laboratory. Two to three weeks of lead time, if possible, will be given to aid the laboratory in scheduling the analytical work. The laboratory will provide the sample containers to the site at least one week before the sampling event is scheduled to begin.

Section 4

SAMPLING APPROACH

This section describes the technical approach for soil sampling including the specific objectives, location, frequency and number of samples to be collected, for each type of soil sample. This information is also summarized in Table 4-1.

This section begins with an overview of the planned cleanup activities and explains the different types of samples which will be collected in association with each activity. A detailed approach for each type of sample is then discussed in the subsequent subsections. The order of sample collection will correspond with the order of each of the related cleanup activities.

Two categories of sampling and analysis are herein defined for the soil cleanup action; "verification" samples, which will be analyzed by the onsite laboratory and "confirmation" samples, which will be analyzed by the offsite laboratory(s).

4.1 Overview of the Soil Cleanup Action and Associated Sampling Activities

This section provides an overview of the planned soil cleanup action and associated sampling activities. The soil cleanup action is described in more detail in Section 4 of the Soil Treatment Plan. The indicator chemicals for the soil cleanup are PCBs and TPH and their respective cleanup levels are:

<u>Medium</u>	<u>PCBs</u>	<u>TPH</u>
Shallow Soils (≤ 15 ft deep)	10 mg/kg	200 mg/kg
Deep Soils (> 15 ft deep)	60 mg/kg	200 mg/kg

The chemical-containing soils will be excavated from several planned areas as shown on Figure 4-1. The boundaries of these areas are based on the extent of

chemicals determined in the previous site investigations. The excavation area boundaries shown, however, may change depending upon the results of soil sampling. Each of these areas are further subdivided by depth (shallow and deep soils) due to the difference in cleanup levels and the type of cleanup action that will be performed, as described below.

Soils will initially be removed in layers from the excavation areas. Verification samples of soil at the excavation boundaries will be collected for indicator chemical analysis. The verification sample results from each excavation will then be evaluated for compliance with the cleanup levels using the statistical procedures described in Section 3.3 of the Data Management Plan. If the sampling results indicate the area is not in compliance, additional soil will be removed and the area will be re-sampled. After an area has been determined to meet cleanup levels based on the verification samples, confirmation analysis will be conducted before discontinuing excavation.

The excavated soil will be screened to remove the clean gravel, cobble and boulder fraction (+ 1 inch material) of the soil. The screening (also referred to as volume reduction) will be performed to 1) improve the efficiency of the vitrification process by removing the clean "cobble", and 2) to reduce the volume of chemical-containing soil. The cobble will initially be stockpiled and will be returned to the excavation areas as backfill following confirmation of its cleanliness. The finer-grained (chemical-containing) materials will be placed in treatment cells and vitrified. Vitrification involves melting of the soil, which causes thermal destruction of chemicals. (The vitrification process is described in more detail in the Soil Treatment Plan.) The effectiveness of vitrification will be tested by the sampling and analysis of the treated soil.

Soils greater than 30 feet deep in the West Dry Well Area which contain chemicals in excess of the cleanup levels will be grouted. The success of the grout placement will be evaluated by sampling and analyzing soils around the grouted areas.

Excavated areas confirmed as meeting cleanup levels will be filled and leveled with clean backfill material. Backfill material will also be used to complete final grading

of the site as a whole. All backfill materials will be sampled and analyzed and indicator chemical concentrations must be below cleanup levels before placement.

4.2 Excavation Sampling

The objectives of the excavation sampling are, first, to direct excavation and, second, to demonstrate that the site has been cleaned to below cleanup levels for the indicator chemicals.

Excavation samples will be collected from a 15-foot grid as shown in Figure 4-2. The origin of the grid will be a random point generated as described in Table 4-2. A minimum of five samples will be collected from each excavation area. For each excavation area, the following sampling procedure will be performed for each of the indicator chemicals. Procedures for each of the calculation steps are given in the Data Management Plan.

- Step 1. Collect excavation verification samples from the floor and walls of the excavated area to evaluate the need for further excavation. Analyze the samples using the onsite laboratory. If any sample contains concentrations greater than twice the appropriate cleanup level, re-excavate and re-sample the area from which that sample was collected. If more than ten percent of the samples exceed the cleanup level, initiate further excavation in the appropriate areas and re-sample.
- Step 2. Calculate the mean and standard deviation of the sample set. Then calculate the required number of verification samples as described in Section 3.3.1 of the Data Management Plan. Check if the required number of samples has been collected. If the required number has not been collected, collect additional samples as needed.
- Step 3. Calculate the upper confidence limit of the mean of the verification samples for the area as described in Section 3.3.1 of the Data Management Plan. Compare the upper confidence limit of the mean with the appropriate cleanup level for the depth.

If the upper confidence limit of the mean is above the cleanup level, conduct further excavation of the area where the highest concentrations have been detected and re-sample. If it is below the cleanup level, proceed to Step 4 for confirmation.

- Step 4. If all of the requirements in the steps above have been met, randomly select ten percent of the verification samples (or a minimum of two for each excavation area) for submission to the offsite laboratory for rapid-turnaround confirmation analysis.
- Step 5. Recalculate the upper confidence limit of the mean using the combined set of verification and confirmation samples as described in Section 3.3.2 of the Data Management Plan. If the upper confidence level of the mean exceeds cleanup levels, conduct additional excavation and re-sample. If the upper confidence limit on the mean is below cleanup levels, less than ten percent of the samples exceed the cleanup limit and no single sample is greater than two times the cleanup level, proceed to Step 6.
- Step 6. The Project Environmental Scientist shall review the verification and confirmation sample results and statistical calculations to ensure that the reported concentrations are below the cleanup level. The Project Environmental Scientist shall sign the calculation worksheets as approved before authorizing backfilling of each area.

The grid origin, final sample locations, and the final excavation limits shall be surveyed for elevation and horizontal position (state plane coordinates) by a licensed surveyor. Coordinates for each sample point will be recorded in the sample logbook.

4.3 Cobble Sampling

Samples of the volume reduction cobbles will be collected as processed and analyzed to verify cleanliness prior to return of the cobble material to excavated areas as backfill. Verification samples of the cobble will be collected at a frequency of one per 50 cubic yards.

The verification samples will be collected directly from the volume reduction equipment using the grab sampling method in Section 6.1. The verification samples of cobble material will be crushed by an offsite laboratory, then analyzed onsite for the indicator chemicals. If the indicator chemicals are not detected at concentrations above cleanup levels in the verification samples, ten percent of the samples will be sent to the offsite laboratory for confirmation analysis. If the indicator chemicals are detected at concentrations above cleanup levels, the cobble will be properly treated as described in the Soil Treatment Plan.

4.4 Backfill Sampling

All imported backfill will be sampled to verify that it is clean prior to placement. Backfill material will initially be stockpiled onsite. The stockpiles will be sampled using grab sampling methods at a frequency of one sample per 100 cubic yards. The backfill verification samples will be analyzed for indicator chemicals using the onsite laboratory. If indicator chemicals are not detected above cleanup levels, ten percent of the backfill samples will be sent to the offsite laboratory for confirmation analysis. If indicator chemicals are detected above cleanup levels, the material will be rejected and returned to the supplier. The sample results will be reviewed by the Project Environmental Scientist before authorizing backfilling.

4.5 Treated Soils Sampling

The objective of sampling the treated soils is to verify the attainment of cleanup levels through vitrification. In order to accomplish this, the strategy proposed by Geosafe in its *Demonstration Test Plan* (Geosafe, 1990) for the ISV technology will be used. This strategy will involve collecting one confirmation sample of treated soils from the center of each "cell" or vitrification area. (No verification samples of the treated soils will be collected.) The samples of the treated soils will be collected by dip sampling as described in Section 6.3. The treated soil confirmation samples will be pulverized and analyzed for indicator chemicals by the offsite laboratory on a rapid-turnaround basis. The sample results from each cell will be evaluated by the

Project Environmental Scientist to ensure that the treated soils are below cleanup levels before authorizing discontinuation of vitrification.

4.6 Sampling to Confirm Placement of Grout

The effectiveness of grouting as a remedy will be established in the pilot test described in the Soil Treatment Plan. Samples of grouted material will not be collected during the implementation of grouting because the collection of samples (e.g., the coring process) may affect the integrity of the grout. However, samples will be collected from soils adjacent to the grouted materials to verify the absence of indicator chemicals in the surrounding soils and confirm that all soils above cleanup levels have been grouted.

Boreholes will be drilled every ten linear feet around the perimeter of the grouted area and verification samples will be collected every ten feet of depth from each boring. The verification samples will be collected using a split-spoon sampler as described in Section 6.2. The verification samples will be analyzed onsite for the indicator chemicals.

The statistical procedures in the Data Management Plan will be used to evaluate compliance with cleanup levels. If the area is not in compliance, additional areas will be grouted and re-sampled. When the verification samples are found to indicate compliance, ten percent of the samples will be selected as confirmation samples for offsite analysis of the indicator chemicals.

The Project Environmental Scientist will review the sample results to ensure compliance with cleanup levels before authorizing discontinuation of the grouting program.

Section 5

SAMPLE DESIGNATION

A coding system will be used to identify each soil sample collected during the RD/RA activities. The system will allow for quick data retrieval and tracking to account for all samples, and will ensure that each sample has a unique identification number. The code will be no more than eight characters in length so as to correspond with format requirements of the project database. The coding protocol will be as follows:

- A two-letter designator code will be used as follows:
 - ES = Soil samples from excavation areas.
 - CS = Samples of volume-reduction cobble material.
 - BF = Samples of imported backfill.
 - GP = Samples of treated soil.
 - GA = Samples to confirm placement of grout.
- The two-letter designator code will be followed by a two or three digit numeric code indicating the chronological sequence of sample collection for each sample series.
- Field quality control samples such as duplicates will be submitted to the laboratory "blind" by assigning the next consecutive sample number for the appropriate series. Onsite laboratory replicates will be designated with the suffix "R". This information will be recorded in the sample logbook.

Section 6

SAMPLING PROCEDURES

This section describes the procedures to be used for collection of soil samples for the RD/RA project. The procedures are designed to ensure that samples are collected in a manner that is consistent and maintains sample integrity.

Three methods will be used to collect soil samples: grab sampling, split-spoon sampling, and dip sampling of treated soils. The grab sampling method will be used when the soil is readily accessible, as for excavation areas and stockpiles. This method is described in Section 6.1. Samples in grouted areas will require the use of mechanized drilling equipment to achieve the desired depth. These samples will, therefore, be collected with a standard split-spoon sampler advanced with a drilling rig as described in Section 6.2. Samples of the soils treated by vitrification will be collected by dip sampling as described in Section 6.3. A list of equipment and supplies required for soil sample collection is provided in Table 6-1.

All samples will be collected in the sample containers listed, and preserved as described, in Section 7. Sample designation will be in accordance with Section 5 of this Soil Sampling and Analysis Plan. Samples for offsite analysis will be handled and shipped in accordance with the procedures in Section 7. The chain-of-custody guidelines specified in Section 4 of the Quality Assurance Project Plan (Part 4 of the Compliance Monitoring Plan) will be followed for offsite sample transfers. All sample locations will be noted in the sample logbook and on the sample location map as described in Section 7.4 of the Quality Assurance Project Plan. The sampling equipment will be cleaned prior to and between collection of each sample, according to Section 5 of the Quality Assurance Project Plan. Any changes from these procedures which may become necessary during field activities will be described on the sample alteration checklist (in Appendix A of the Quality Assurance Project Plan).

6.1. Grab Samples

Each soil grab sample will be collected by hand with a clean trowel. Samples will be collected from just below the surface (4 to 6 inches) of the soil. The procedure for grab sampling will be as follows:

- Use the previously decontaminated trowel to remove any loose or smeared soil from the sample location;
- Insert the trowel approximately four to six inches into the soil;
- Remove the trowel and its soil contents;
- Place the soil from the trowel into a disposable sample homogenization bowl, repeat until approximately 16 ounces have been obtained and mix the sample thoroughly;
- Completely fill two 8-ounce glass jars with the homogenized soil; and
- Clean the trowel before using it to collect the next sample.

6.2 Split-Spoon Samples

Soil drilling to the required depth to collect split-spoon samples will be accomplished using the air-rotary casing hammer method. This drilling method is described in more detail in Section 3.1.1 of the Ground-Water Monitoring Plan. No drilling fluids or additives, other than water from source approved by the Project Environmental Scientist, will be permitted.

The split-spoon sampler will be 2.5 inches (inside) diameter, 18 inches long and will be fitted with three 2.5-inch diameter, 6-inch long clean brass sample tubes. The method to be used for collecting split-spoon samples is as follows:

- Drill to the desired depth and sound the borehole with a weighted tape to confirm the bottom depth;
- Place the brass sample tubes into the split-spoon sampler and assemble the sampler immediately prior to sampling. Attach the sampler to the

drill stem and drive the sampler into the soil using a 140-lb hammer with a 30-inch drop, 18 inches or to refusal, which is defined as 50 blows per six inches of penetration;

- Retrieve and open the sampler, and carefully remove the soil-filled brass tubes;
- Examine the the ends of the soil-filled brass tubes for geologic description, measure sample recovery. Record these observations and mark the sample tubes indicating top and bottom, sample number and depth; and
- Seal the ends of the sample tubes with Teflon cap liners and tightly-fitting plastic end caps. The middle tube will be submitted to the onsite laboratory for analysis. The bottom tube will be retained for offsite analysis. The top tube will be used as necessary for geologic examination. For split or duplicate samples, the contents of two brass sample tubes shall be homogenized in a disposable mixing bowl, then transferred to two 8-ounce glass sample jars with a clean trowel.

The boreholes will be backfilled with neat cement grout after completion. Each borehole will be surveyed for horizontal position and elevation by a licensed surveyor.

6.3 Dip Samples

To verify that no residual chemicals are left within the treated (vitrified) soil, a dip sample will be collected from the center of each vitrification cell. The dip samples will be collected by Geosafe, the vitrification contractor. The dip samples will be obtained using a clean 1-inch diameter, schedule 40 carbon steel pipe. The pipe will be lowered into the melted soil just after the melting has been completed and the power to the electrodes has been shut down. A crane will be used to lower the pipe directly through the center of the off-gas line/hood interface pipe. The sample pipe will penetrate the cold surface cap and the molten glass. As the sample pipe is lowered through the molten glass, the glass will wet the surface of the steel and adhere to the outside of the pipe. As the pipe is lowered to the bottom of the melt, glass will attach to the entire length of the pipe. The pipe will be withdrawn from the melt and placed on a clean surface where the glass will be removed from the

pipe. A glass sample approximately 18 feet long will be obtained from the exterior surface of the pipe. The glass sample will be divided into four quarters lengthwise and composites of the glass will be placed in the sample jars.

The methodology and procedures to be used for the collection of the dip samples are described in more detail in the *ISV Demonstration Test Plan* (Geosafe, 1990) and the *Work Plan for In Situ Vitrification Demonstration Test Support Activities at the Former General Electric Spokane Facility* (Bechtel, 1990).

Section 7

SAMPLE HANDLING, SHIPPING AND ANALYSIS

This section outlines the requirements for sample handling, shipping and analysis.

7.1 Sample Handling and Shipping

Sampling handling requirements are listed in Table 7-1. These include the minimum required sample volume, sample containers to be used, sample preservation requirements, and maximum holding times allowed.

Samples will be packaged for shipment as follows:

- Secure caps with tape;
- Attach sample label to each container;
- Place clear tape seal over label;
- Wrap glass jars in bubble wrap bag;
- Place on ice in an ice chest;
- Complete chain-of-custody documentation as described in Section 4 of the Quality Assurance Project Plan, enclose the chain-of-custody form, carefully wrapped and sealed, in the ice chest; and
- Affix signed and dated custody seals to coolers and secure with strapping tape.

Samples which will be shipped to the offsite analytical laboratory(s) will be kept at a temperature of 4°C from the time of collection through the transport of the samples to the laboratory. The laboratory will store the samples at 4°C until all analyses of the samples have been completed.

Samples will be shipped by overnight common carrier. The samples will be packaged and shipped in accordance with the most current version of the International Air Transport Association (IATA) *Dangerous Goods Regulations* (IATA, 1993). Because some samples may contain reportable quantities (for shipping purposes) of PCBs, the regulations will be reviewed for special instructions before making each shipment.

Samples will be analyzed within U. S. EPA or Contract Laboratory Program (CLP) holding times established for the analyses to be performed as shown in Table 7-1.

7.2 Analytical Procedures

The methods to be used for soil analysis, including method number, type and detection limits, are summarized in Table 7-2. The methods were selected based upon the data quality objectives discussed in Section 2 of the Quality Assurance Project Plan, including the cleanup levels, the analyte(s) of interest, and the detection limit capabilities of the method(s). Generally, methods used in past sampling and analysis at the site were selected to ensure comparability with previous results. An exception is that a new extraction method for onsite analysis of PCBs will be used to improve recovery. Table 7-3 specifies the analytical parameters for PCBs in soil. Actual detection limits obtained during analysis will be reported for each parameter in each sample. High concentration samples or samples containing interfering substances may result in elevated detection limits.

Two types of analytical laboratories will be used: an onsite laboratory, and an offsite confirmation laboratory(s). The onsite laboratory will be used to analyze verification samples. Confirmation samples will be sent to the offsite laboratory(s) for analysis when the onsite laboratory results of the verification samples indicate that cleanup levels have been met. The number of confirmation samples sent will depend on the required number of verification samples, and will generally be either ten percent of the number of verification samples or two samples, whichever is greater.

Specific laboratories have not yet been identified, however, the laboratories selected will be required to be participants in the Contract Laboratory Program or otherwise appropriately qualified.

7.2.1 Onsite Verification Analysis

Two gas chromatographs will be used for onsite laboratory analysis. One gas chromatograph will be equipped with an electron capture detector for detection of Aroclor 1260 according to U. S. EPA Method 8080. The other gas chromatograph will be equipped with an infrared spectrometer for TPH analysis by U. S. EPA Method 418.1. Aroclor 1260 was selected as the PCB indicator for onsite analysis because it is the predominant Aroclor detected in site soils based on the results of previous investigations (*Bechtel, 1991a*). The extracts for analysis will be prepared using a procedure developed by Thomas M. Spittler at the U. S. EPA Region I Laboratory (*U.S. EPA Manchester Laboratory, 1991*). This extraction procedure uses a mixture of hexane, methanol, and water in a ratio of 5:4:1. A florasil column will be used for cleanup as necessary.

7.2.2 Offsite Confirmation Analysis

Confirmation samples will be analyzed for total petroleum hydrocarbons by U. S. EPA Method 418.1 and PCBs (Aroclors 1242, 1254 and 1260) by CLP Routine Analytical Services (RAS). These methods were selected because they meet the requirements for detection limits below the cleanup levels, include the parameters of interest, and are comparable to methods previously used in the site investigations.

The offsite laboratory will also perform special sample preparation according to U. S. EPA methods. Special preparation of samples will include pulverization of the cobble and treated soil before extraction and analysis as soil samples. Split samples and standards used for onsite analysis will also be analyzed by the offsite laboratory as specified in the Quality Assurance Project Plan.

7.3 Quality Control Samples

Quality control samples are discussed in detail in Section 8 of the Quality Assurance Project Plan, and are summarized below. Field quality control samples for the soil sampling program will include duplicates and rinsate samples. Duplicates will be collected at a frequency of one per 20 soil samples collected. Rinsate samples will be collected once per sampling device during each of the following sampling events: excavation sampling, sampling to confirm placement of grout, cobble sampling, and backfill sampling.

Laboratory quality control samples will include method blanks, matrix spikes, and matrix spike duplicates. A minimum of one of each type of quality control sample will be analyzed per batch of 20 samples or less by the offsite laboratory, and a minimum of one each per day will be analyzed by the onsite laboratory. In addition, the onsite laboratory will analyze one replicate per day. As mentioned above, occasional splits of samples analyzed by the onsite laboratory will be sent to the offsite laboratory for analysis, and the offsite laboratory will periodically analyze standards used for onsite analysis.

TABLES

TABLE 1-1

CROSS-REFERENCE TO CONSENT DECREE REQUIREMENTS

<i>Consent Decree Requirement</i>	<i>SSAP Section</i>
Objectives.	1, 2
Schedules and task assignments.	3.1
Access.	3.2
Sampling methods.	5
Locations and ID numbers (map).	4, 5
Order of sample collection.	4.1
Sample objectives:	4.1
(1) samples to determine nature and extent of contamination; and	4
(2) samples to determine performance of remedial actions.	4
QA/QC samples.	7.3
Shipping and handling arrangements.	6
Split sampling opportunities.	3.2
Analytical parameters, including:	
(1) justifications for choice of analyses;	7.1, 7.2
(2) laboratory and analytical method identification, including detection limits;	7.1, 7.2
(3) sample containers, preservation and holding times; and	6
(4) laboratory-generated QA/QC samples.	7.3

TABLE 4-1
SOIL SAMPLE SUMMARY

TYPE	DESIGNATION	FREQUENCY	ANALYSIS	ESTIMATED NUMBER
Excavation Verification	ES	On 15 ft grid	Onsite PCBs and TPH	200
Excavation Confirmation	ES	10% of excavation verification samples	Offsite PCBs and TPH	20
Cobble Verification	CS	1 per 50 cubic yards	Onsite PCBs and TPH ⁽¹⁾	32
Cobble Confirmation	CS	10% of cobble verification samples	Offsite PCBs and TPH ⁽¹⁾	4
Backfill Verification	BF	1 per 100 cubic yards	Onsite PCBs and TPH	15
Backfill Confirmation	BF	10% of backfill stockpile verification, or minimum of 2	Offsite PCBs and TPH	2
Treated Soils	GP	1 per vitrification cell	Offsite TPH and PCBs ⁽¹⁾	13
Grout Placement Verification	GA	Every 10 linear feet around the perimeter, every 10 linear feet of depth	Onsite PCBs and TPH	36
Grout Placement Confirmation	GA	10% of grout placement verification samples	Offsite PCBs and TPH	4

(1) Following pulverization.

TABLE 4-2
EXCAVATION SAMPLING GRID DESIGN

-
- Step 1 - Generate a set of coordinates (X, Y) for the grid origin using the following equations:

$$X = X_{\min} + (X_{\max} - X_{\min}) * \text{RND}$$

$$Y = Y_{\min} + (Y_{\max} - Y_{\min}) * \text{RND}$$

RND is a random number between 0 and 1. Random numbers can be obtained from scientific calculators, personal computers, or a random number table. X max, Y max and X min, Y min, are the maximum and minimum coordinates, respectively, of the excavations, as shown in Figure 4-2.

- Step 2 - If (X, Y) is outside of the area, repeat step 1 with a new set of random numbers. Record (X, Y) - the coordinates of the grid origin. (These coordinates may be rounded to the nearest five feet for convenience in laying out the grid, if desired.)

$$X = \underline{\hspace{2cm}} \quad Y = \underline{\hspace{2cm}}$$

- Step 3 - Lay out the sample grid using a 15-foot spacing as shown in Figure 4-2.
-

TABLE 6-1
SAMPLING EQUIPMENT AND SUPPLIES

Equipment

Logbook
Trowels
Split-spoon sampler
1-inch schedule 40 carbon steel pipe at least 25 feet long
Drilling rigs, equipment and tools for split spoon sampling
Ice chests (IATA-approved)
100-foot tape
Pocket transit and tripod
Folding carpenter's ruler

Supplies

Survey stakes, string and flags
8-oz. glass jars, pre-cleaned in a manner suitable for EPA Method 8080 analysis
Disposable paper mixing bowls
2.5-inch diameter, 6-inch long brass sample tubes
Plastic bags
Sample labels
Sealing tape
Protective packaging material (bubble wrap, etc.)
3-inch Teflon film
2.5-inch plastic end caps for brass sample tubes
Indelible markers
Ice

TABLE 7-1
SAMPLE CONTAINERS, PRESERVATIVES AND HOLDING TIMES

LABORATORY	PARAMETER	MINIMUM SAMPLE VOLUME	PRESERVATIVE	CONTAINER	HOLDING TIME (DAYS) ^(a)
A. Onsite Verification	Aroclor 1260 TPH	4 oz.	Cool to 4°C	Glass Jar ^(b)	(c)
		4 oz.	Cool to 4°C	Glass Jar ^(b)	(c)
B. Offsite Confirmation	PCBs TPH	4 oz.	Cool to 4°C	Glass Jar ^(b)	14/40 ^(d)
		4 oz.	Cool to 4°C	Glass Jar ^(b)	28

- (a) *Test Methods for Evaluating Solid Wastes, EPA SW-846, Revision 1, November 1990 (U.S. EPA, 1990a).*
- (b) Or brass sample tube.
- (c) Field analysis will be performed immediately so holding times are not applicable.
- (d) The number before the slash is the maximum days before extraction. The number after the slash is the maximum days between extraction and analysis.

TABLE 7-2
ANALYTICAL METHODS

<i>Parameter</i>	<i>Method Number</i>	<i>Method</i>	<i>Detection Limits (mg/kg)</i>
I. PCBs			
Onsite verification	EPA 8080 (c)	GC/ECD (b)	1
Offsite confirmation	CLP RAS (a)	GC/ECD (b)	0.033
II. Total Petroleum Hydrocarbons			
Onsite verification	EPA 418.1 (d)	IR (e)	10
Offsite confirmation	EPA 418.1 (d)	IR (e)	10

(a) Analytical method obtained from *Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration*, March 1990 (U.S. EPA, 1990b).

(b) GC/ECD = Gas chromatograph/electron capture detector.

(c) Analytical method obtained from *Test Methods for Evaluating Solid Waste, EPA SW-846, 3rd edition* (U. S. EPA, 1986).

(d) Analytical methods obtained from *Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revision March 1983* (U.S. EPA, 1983).

(e) IR = Infrared spectroscopy.

TABLE 7-3
ANALYTICAL PARAMETERS FOR PCBS

<i>PCBs (CLP RAS)</i>	<i>CAS Number</i>	<i>Detection Limits(a) mg/kg</i>
Aroclor-1242	53469-21-9	0.033
Aroclor-1254	11097-69-1	0.033
Aroclor-1260	11096-82-5	0.033

References: *Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration (U.S. EPA, 1990b).*

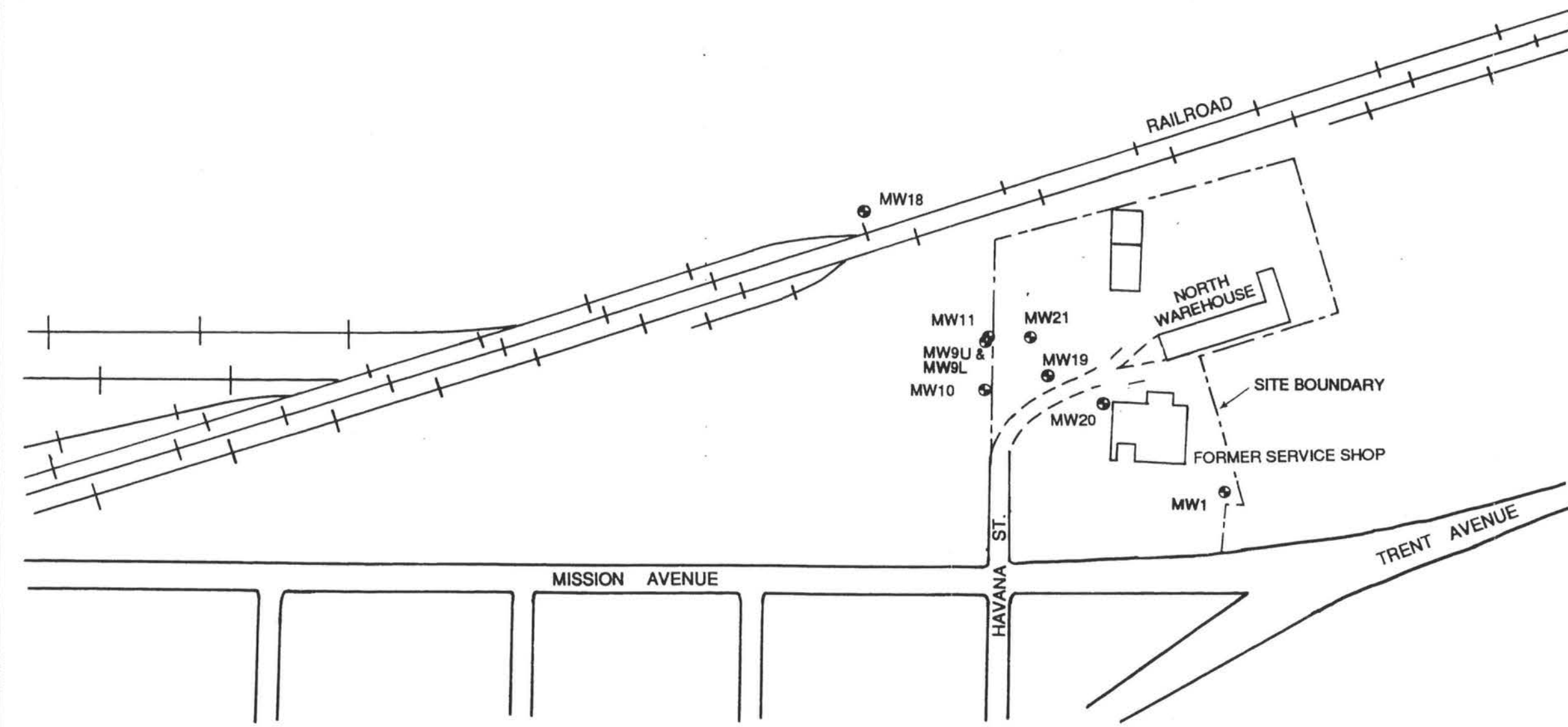
- (a) Detections limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment on a dry weight basis as required by the contract, will be higher.

FIGURES

SPOKANE RIVER

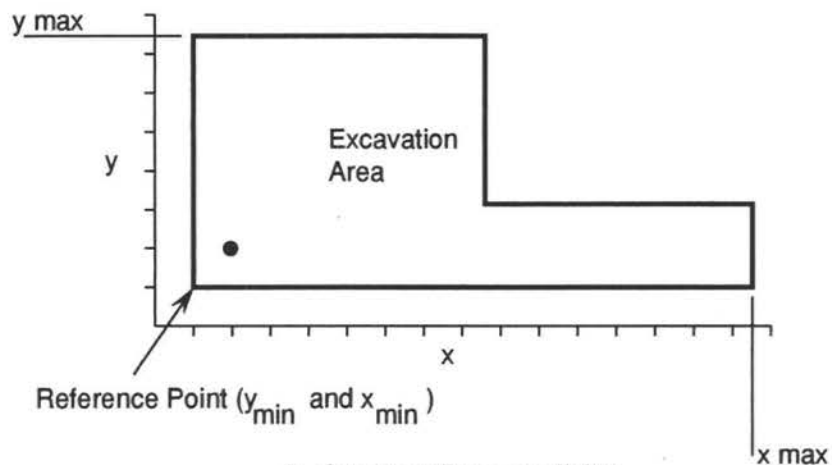
EXPLANATION

MW-1
● Monitoring well

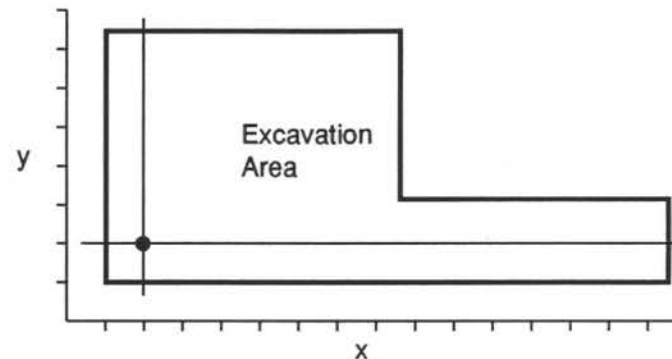


BECHTEL SAN FRANCISCO			
GENERAL ELECTRIC/SPOKANE			
PROPOSED GROUND-WATER MONITORING NETWORK			
	JOB No.	DRAWING No.	REV.
	19099	FIGURE 4-1	D

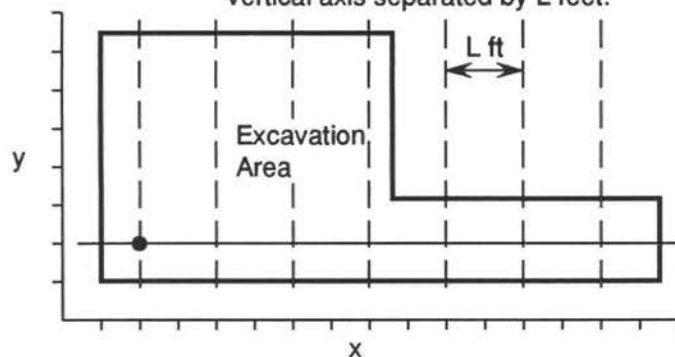
1. Select random point (see Table 4-2).



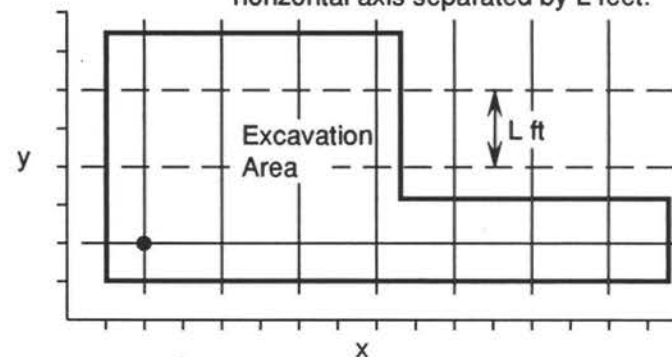
2. Construct coordinate axes going through initial point.



3. Construct lines parallel to vertical axis separated by L feet.



4. Construct lines parallel to the horizontal axis separated by L feet.



NOTE:

Typical grid spacing (L) will be 15 feet.

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EXCAVATION SAMPLING GRID



Job Number

19099

Drawing No.

FIGURE 4-2

Rev.

B

GE-SPOKANE REMEDIAL DESIGN/REMEDIAL ACTION PROJECT

COMPLIANCE MONITORING PLAN
PART 2

GROUND-WATER SAMPLING AND ANALYSIS
PLAN

Prepared for

GENERAL ELECTRIC COMPANY

by

BECHTEL ENVIRONMENTAL, INC.

San Francisco, California

December 1993



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Appendices (in section following figures)

A	Operating Instructions for Hydrostar Sampling Pump
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Section 1

INTRODUCTION

This Ground-Water Sampling and Analysis Plan was prepared by Bechtel Environmental, Inc. (Bechtel), for General Electric Company (GE) as Part 2 of the Compliance Monitoring Plan. The Compliance Monitoring Plan is one of the Project Plans for the GE-Spokane Remedial Design/Remedial Action (RD/RA) Project, as required under the *Consent Decree* (WDOE, 1993b) between GE and the Washington Department of Ecology (WDOE). This plan provides the procedures for ground-water sampling and analysis.

Section 2 of this plan presents the sampling objectives. Section 3 discusses WDOE access and sampling event planning. Section 4 presents sampling locations and frequency and Section 5 discusses sample designation. Section 6 discusses methods and procedures for sample collection, and Section 7 discusses sample handling, shipping, and analysis requirements. Table 1-1 provides a cross-reference indicating where the Consent Decree requirements are addressed in this plan.

The RD/RA project is described in the foreword to the Compliance Monitoring Plan. References cited in this plan are provided at the end of the Compliance Monitoring Plan. Quality assurance/quality control procedures for ground-water monitoring are presented in the Quality Assurance Project Plan, Part 4 of the Compliance Monitoring Plan. The rationale for selection of the sampling locations (i.e., monitoring well locations) is provided in the Ground-Water Monitoring Plan. Procedures for the evaluation of ground-water monitoring data are provided in the Data Management Plan.

Section 2

SAMPLING OBJECTIVES

The primary objective of this Ground-Water Sampling and Analysis Plan is to prescribe procedures for ground-water sampling and analysis. Specific objectives of the ground-water sampling and analysis are to:

- Determine if cleanup activities have lowered the mean concentration indicator parameters for ground water to below cleanup levels; and
- To ensure that the Data Quality Objectives (DQOs) for ground-water sampling are met.

The DQOs developed to meet the sampling and analysis objectives discussed above are provided in the Quality Assurance Project Plan, Part 4 of the Compliance Monitoring Plan.

Section 3

SAMPLING EVENT PLANNING

This section describes the elements considered for successful planning of the ground-water sampling. These elements include schedule and task assignments for sampling activities, access considerations and split sampling opportunities for WDOE, and preparation of Sampling Execution Plans.

3.1 Schedule and Task Assignments

The overall project schedule is provided in Figure 4-1 of the Summary Cleanup Action Planning Report. The ground-water samples will be collected on a quarterly schedule beginning in late 1993.

Supervision and planning of sampling tasks will be assigned to the data management team. The data management team is comprised of the following personnel under the direction of the Project Environmental Scientist: the Project Quality Assurance Manager, the Data Manager, the Data Coordinator, and the Database Manager. Samples will be collected by field sampling personnel. The responsibilities of each of the data management team members are described in Section 1.2 of the Quality Assurance Project Plan. An organization chart showing the relationship of the data management team members is provided in Figure 1-1 of the Quality Assurance Project Plan. The data management team will be involved in all phases of project planning that affect data acquisition, including development of this Ground-Water Sampling and Analysis Plan.

3.2 WDOE Access and Split Sampling Opportunities

Access to the site will be provided to WDOE during normal working hours for split sampling, inspections, etc. The WDOE Project Coordinator should provide 24 hours notice to Bechtel to obtain access.

Written advance notice of each sampling activity will be sent by Bechtel to the WDOE Project Coordinator at least seven days before the commencement of field work. If split samples are requested by WDOE (for audit purposes), other regulatory agencies, or other concerned party, the following is the procedure for providing the split samples:

- 1) The party requesting the split sample(s) must notify Bechtel prior to split sample collection.
- 2) The number of samples collected at a single sampling point will be multiplied by the required number of split samples.
- 3) The sample(s) will be placed in separate containers provided by the requestor and all remaining handling (including labeling, packing, shipping, and analysis) will be the responsibility of the party requesting the split sample(s).
- 4) Collection of the split samples will be documented in the sample logbook.
- 5) The field sampling personnel will receive a receipt from the party requesting the split sample(s).

3.3 Sampling Execution Plans

Prior to the beginning of any sampling event, the Project Environmental Scientist will coordinate with the field sampling personnel and data management team to create a Sampling Execution Plan. The purpose of the Sampling Execution Plan is to ensure that all field sampling and data management personnel have a clear understanding of what each sampling event entails. The Sampling Execution Plan will consist of a table showing the number of samples, sampling areas or locations,

sample identification numbers, constituents to be analyzed, sample containers/preservatives, all associated quality control samples required, and the anticipated dates of sampling and reporting of results, as based on the procedures specified herein. The Sampling Execution Plan, and any deviations from the Sampling Execution Plan, including sampling and analysis requests outside the original scope of work, will be approved by the Project Manager.

Each round of sampling will be initiated by Bechtel by providing a copy of the Sampling Execution Plan to the analytical laboratory. Two to three weeks of lead time, if possible, will be given to aid the laboratory in scheduling the analytical work. The laboratory will provide the sample containers to the site at least one week before the sampling event is scheduled to begin.

Section 4

SAMPLE LOCATIONS AND FREQUENCY

The sample locations and frequency are discussed in this section. The planned sample locations (locations of the monitoring wells) at the GE-Spokane site are shown on Figure 4-1. The rationale for the selection of the well locations is provided in the Ground-Water Monitoring Plan.

Ground-water samples will be collected on a quarterly basis from both existing and new wells that will comprise the ground-water monitoring network. The ground-water samples collected from the monitoring wells will be analyzed for PCBs on a quarterly basis and for volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPH) on an annual basis (each winter). The procedures that will be used for collecting ground-water samples are described in Section 6. The type and frequency of quality control samples are discussed in Section 7.

Section 5

SAMPLE DESIGNATION

A coding system will be used to identify each sample collected. The system will allow for quick data retrieval and tracking to account for all samples, and will ensure that each sample has a unique identification number. The code will be less than eight characters in length so as to correspond with format requirements of the project database. The coding protocol will be as follows:

- The first two or three digits indicate the monitoring well from which the sample was collected, for example:
 - 20 for monitoring well MW20; and
 - 09U for monitoring well MW9U.
- The last four digits represent the quarter and the year when the sample was collected, for example:
 - 1Q94 for the first quarter of 1994.
- Therefore, a sample labeled 204Q93 is a ground water sample taken from monitoring well MW20 during the fourth quarter of 1993.
- Field quality control (blank and duplicate) samples will be designated with an unused well number, such as MW25, so that they may be submitted "blind" to the analytical laboratory.

Section 6

SAMPLING PROCEDURES

This section describes the methods and procedures to be used in collecting ground-water samples during the GE-Spokane ground-water monitoring program. The procedures are designed to ensure that ground-water samples are collected, labeled, preserved and transported to the laboratory in a manner that is consistent and maintains sample integrity.

6.1 Sample Collection Methodology

Ground-water samples will be collected from wells as described below. All measuring and sampling equipment will be cleaned before use in a well as described in Section 5.1 of the Quality Assurance Project Plan. Cleaned equipment will be placed on new plastic sheeting until used. The sampling equipment will be limited to those items made with stainless steel, Teflon, and glass to reduce the possibility of cross-contamination and leaching of organics from the equipment. A list of sampling equipment and supplies is provided in Table 6-1. Samples will be collected first from wells which have historically shown lower levels of chemicals in order to minimize the potential for cross-contamination of samples.

Water-level measurements will be taken in each well prior to purging and sampling, and before any equipment is lowered into the well. Measurements will be made from a permanently marked reference point on the PVC well casing above ground surface. Measurements will be made using an electric probe and recorded to the nearest hundredth of a foot.

Ground-water samples will be obtained from each monitoring well with a dedicated Hydrostar (model HS 8000) stainless steel pump system and dedicated sampling port made of Teflon. The operating instructions for the Hydrostar HS 8000 are provided in Appendix A. Ground water will be purged from each well and pumped into 55-

gallon drums. A minimum of three well volumes will be removed from each well to ensure that the sample is representative of ground water. In the unlikely event that a well is pumped dry during purging, the well will be pumped dry two times, allowing 80 percent water-level recovery between purges and prior to sampling.

During ground-water purging, indicator parameters (i.e., pH, electrical conductivity, turbidity, and temperature) will be monitored to verify that the water to be sampled is representative of ground water from the formation. The measurements will be recorded on a well sampling form, which can be found in Appendix A of the Quality Assurance Project Plan. Samples for chemical analysis will not be collected until all indicator parameters have stabilized (i.e., three consecutive readings exhibit values within ten percent).

Immediately following purging, ground-water samples will be transferred from the wells via the dedicated pumps directly to the appropriate sample containers. The types of containers, volume of water to be collected, and preservation methods for each analysis type are described in Table 6-1. When transferring samples to the container, care will be taken not to touch the sampling port to the sample container. When filling containers for VOC analysis, care shall be taken to minimize agitation and loss of volatiles by using a low flow rate and completely filling each container so that there is no entrained air.

Quality control samples will be collected in triplicate volume and submitted to the laboratory for matrix spike and matrix spike duplicate analysis for every quarterly batch. The chain-of-custody record will clearly indicate samples to be analyzed for quality control purposes.

Sample containers will be packaged and shipped as described in Section 7.

6.2 Handling of Residual Materials

Procedures for handling residual materials generated during ground-water sampling are described in Section 3.2 of the Investigative and Project Waste Management Plan and are briefly summarized below.

Purged ground water will be contained in Department of Transportation (DOT) approved 55-gallon drums or an approved alternate container (polyethylene tank). Purged ground water collected onsite and offsite will be temporarily stored in the designated area on the GE-Spokane site.

Section 7

SAMPLE HANDLING, SHIPPING, AND ANALYSIS

This section outlines the requirements for ground-water sample handling, shipping, and analysis. Sampling handling requirements are listed in Table 7-1. These include the minimum required sample volume, sample containers to be used, sample preservation requirements, and maximum holding times allowed. Pre-cleaned sample containers will be supplied by the laboratory. Samples to be transmitted to the offsite laboratory will be handled under the chain-of-custody requirements outlined in Section 4 of the Quality Assurance Project Plan.

Samples will be packaged for shipment as follows:

- Secure caps with tape;
- Attach sample label to each container;
- Place clear tape seal over label;
- Wrap glass jars in ziplock bag or place in bubble wrap bag;
- Store on ice in an ice chest;
- Complete chain-of-custody documents, wrap and seal, and place in the ice chest; and
- Affix signed and dated custody seals to coolers and seal with strapping tape.

Samples will be shipped to the offsite laboratory and will be kept at a temperature as close to 4°C as possible from the time of collection through the transport of the samples to the laboratory.

Samples will be shipped by overnight common carrier. The samples will be packaged and shipped in accordance with the most current version of the

International Air Transport Association (IATA) *Dangerous Goods Regulations* (IATA, 1993). Because some samples may contain reportable quantities (for shipping purposes) of PCBs, the regulations will be consulted for special instructions before making each shipment.

The laboratory will store the samples at 4 °C until all analyses for those samples have been completed. Samples will be analyzed within U. S. EPA holding times established for the analyses to be performed.

All ground-water samples will be analyzed for PCBs quarterly and will be analyzed for volatile organics and total petroleum hydrocarbons annually. The methods to be used for ground-water analysis, including method numbers and types, are summarized in Table 7-2. The methods were selected based upon the Data Quality Objectives in the Quality Assurance Project Plan, including the cleanup levels, analyte(s) of interest, and detection limit capabilities of the method(s). Tables 7-3 and 7-4 specify the analytical parameters and detection limits. Actual detection limits obtained during analysis will be reported for each parameter in each sample. High concentration samples or samples containing interfering substances may result in elevated detection limits.

Ground-water samples will be analyzed for PCBs using Contract Laboratory Program (CLP) Special Analytical Services (SAS) following a modified extraction method outlined in *Extraction of BNAs/PEST/PCB/OP-PEST in Water* (U. S. EPA Manchester Laboratory, 1991). A practical quantitation limit (PQL) of 0.05 µg/L was obtained in a method detection limit study performed by Golder Associates (Golder, 1992a) using the ground water from MW12 subjected to the modified extraction method. Modifications in the extraction method include:

- Extraction of a three liter, instead of one liter, sample volume;
- Use of a stir-bar method; and
- Concentration of the sample to a final volume of one milliliter.

Detection limits for CLP RAS volatiles and TPH will be sufficient for performance monitoring of VOCs and TPH at the site.

Specific laboratories have not yet been identified, however, the laboratories selected will be required to be participants in the CLP, or otherwise appropriately qualified.

Quality control samples are discussed in detail in the Quality Assurance Project Plan, and are summarized below. Field quality control samples for the ground-water sampling program will include duplicates. Duplicates will be collected at a frequency of one per quarterly round. Laboratory quality control samples will include method blanks, matrix spikes, and matrix spike duplicates. A minimum of one of each type of quality control sample will be analyzed per quarterly round of samples. One trip blank will be analyzed for VOCs for each round of ground-water samples analyzed for VOCs.

TABLES

TABLE 1-1

CROSS-REFERENCE TO CONSENT DECREE REQUIREMENTS

<i>Consent Decree Requirement</i>	<i>GWSAP Section</i>
Objectives.	1
Schedules and task assignments.	3
Access.	3
Samples:	
1. Sampling methods and equipment.	6
2. Locations and identification numbers (map).	Figure 4-1
3. List order of sample collections.	6.1
4. Sample objectives:	2
a. Samples to determine nature and extent of chemicals in ground water; and	2
b. Samples to determine performance of "remedial" actions.	2
5. QA/QC samples.	7
6. Shipping and handling arrangements.	7
7. Split sampling opportunity.	3
8. Analytical parameters, including:	Table 7-2
a. Justification for choice of analyses;	7
b. Laboratory and analytical method identification, including detection limits;	Tables 7-2, 7-3, & 7-4
c. Sample containers, preservation, and holding times; and	Table 7-1
d. Laboratory-generated QA/QC samples.	7
9. List of supplies and equipment.	Table 6-1

TABLE 6-1
SAMPLING EQUIPMENT AND SUPPLIES

Equipment

Steel brush
pH meter
Conductivity meter
Thermometer
Turbidity meter
Logbook and sampling forms
Calculator for purge volume calculation
Tool box (to include at least screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench, vise grips, utility knives)
5-gallon pail
DOT-approved 55-gallon drums

Supplies

Visqueen or plastic sheeting
Coolers for shipping sample containers to laboratory
Chain of custody forms
Chain of custody seals
Sample containers
Labels for containers
Styrofoam peanuts
Bubble wrap
Strapping tape
Clear tape
Duct tape
Ziploc plastic bags, 1-gallon capacity
Federal Express forms
Ice

TABLE 7-1
SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

<i>Parameter</i>	<i>Minimum Sample Volume</i>	<i>Preservative</i>	<i>Container</i>	<i>Holding Time</i>
PCBs	1 x 4 liters	Cool to 4° C	Amber glass	7 days
TPH	1 x 1 liter	Add HCl to pH <2 Cool to 4° C	Glass	7 days
VOCs	2 x 40 mL	Add HCl to pH <2 Cool to 4° C	Glass vials	14 days

TABLE 7-2
ANALYTICAL METHODS

<i>Parameter</i>	<i>Method Number</i>	<i>Method</i>	<i>Detection Limits ($\mu\text{g/L}$)(a)</i>
I. PCBs	EPA 608 (g)	GC/ECD ^(b) (modified low level extraction) (d)	0.05
II. Total Petroleum Hydrocarbons	EPA 418.1 (c)	IR (e)	100
III. Volatile Organics	CLP RAS (f)	GC/MS (f, g)	10

(a) Specific detection limits for volatile organic compounds and PCBs are provided in Tables 7-3 and 7-4.

(b) GC/ECD = Gas chromatograph/electron capture detector.

(c) Analytical method obtained from *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, Revision March 1983 (U.S. EPA, 1983).

(d) From *Extraction SOP for BNAs/PEST/PCB/OP-PEST in Water*, Version 1.0, March 1991 (U.S. EPA Manchester Laboratory, 1991).

(e) IR = Infrared spectroscopy.

(f) Analytical methods obtained from *Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration*, March 1990 (U.S. EPA, 1990).

(g) GC/MS = Gas chromatograph/mass spectrometer.

TABLE 7-3

**TARGET COMPOUND LIST AND CONTRACT-REQUIRED DETECTION
LIMITS FOR VOCs**

<i>Volatiles (CLP RAS)</i>	<i>CAS Number</i>	<i>Contract-Required Detection</i>
		<i>Limits^(a)</i> <i>µg/L</i>
Chloromethane	74-87-3	10
Bromomethane	74-83-9	10
Vinyl Chloride	75-01-4	10
Chloroethane	75-00-3	10
Methylene Chloride	75-09-2	10
Acetone	67-64-1	10
Carbon Disulfide	75-15-0	10
1,1-Dichloroethene	75-35-4	10
1,1-Dichloroethane	75-34-3	10
1,2-Dichloroethene (total)	540-59-0	10
Chloroform	67-66-3	10
1,2-Dichloroethane	107-06-2	10
2-Butanone	78-93-3	10
1,1,1-Trichloroethane	71-55-6	10
Carbon Tetrachloride	56-23-5	10
Vinyl Acetate	108-05-4	10
Bromodichloromethane	75-27-4	10
1,2-Dichloropropane	78-87-5	10
cis-1,3-Dichloropropene	10061-01-5	10
Trichloroethene	79-01-6	10
Dibromochloromethane	124-48-1	10
1,1,2-Trichloroethane	79-00-5	10
Benzene	71-43-2	10

TABLE 7-3 Cont'd.

**TARGET COMPOUND LIST AND CONTRACT-REQUIRED DETECTION
LIMITS FOR VOCs**

<i>Volatiles (CLP RAS)</i>	<i>CAS Number</i>	<i>Contract-Required Detection</i>
		<i>Limits^(a)</i> <i>µg/L</i>
trans-1,3-Dichloropropene	10061-02-6	10
Bromoform	75-25-2	10
4-Methyl-2-pentanone	108-10-1	10
2-Hexanone	591-78-6	10
Tetrachloroethene	127-18-4	10
Toluene	108-88-3	10
1,1,2,2-Tetrachloroethane	79-34-5	10
Chlorobenzene	108-90-7	10
Ethyl Benzene	100-41-4	10
Styrene	100-42-5	10
Xylenes (Total)	1330-20-7	10

Reference: *Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration*
(U. S. EPA, 1990).

TABLE 7-4

ANALYTICAL PARAMETERS AND PRACTICAL QUANTITATION LIMITS
FOR PCBS

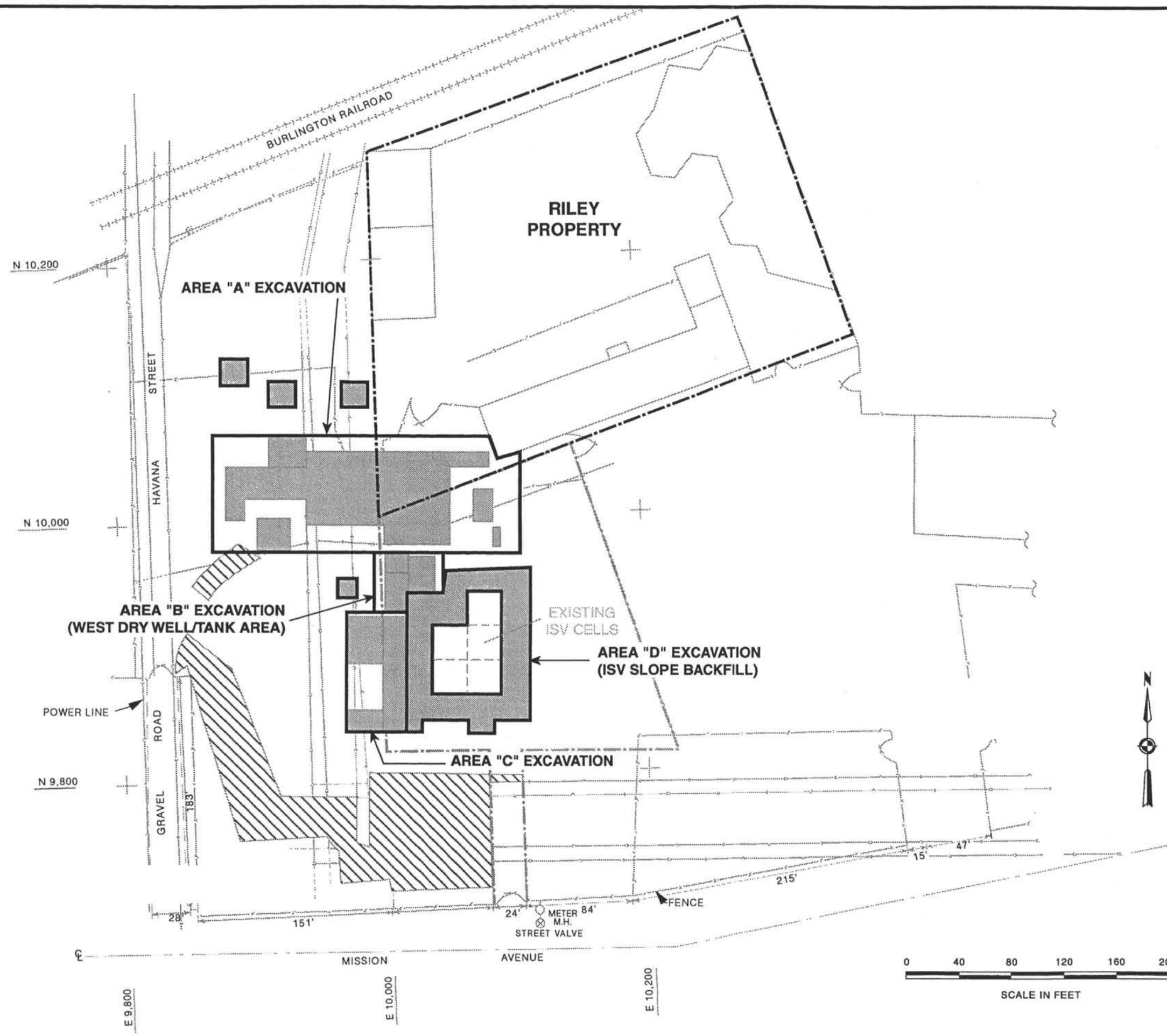
<i>PCBs CLP SAS (a)</i>	<i>CAS Number</i>	<i>Practical Quantitation Limits^(b) µg/L</i>
Aroclor-1242	53469-21-9	0.05
Aroclor-1254	11097-69-1	0.05
Aroclor-1260	11096-82-5	0.05

(a) Modified low level extraction (U.S. EPA Manchester Laboratory, 1991).

(b) The PQL of 0.05 µg/L was obtained for Aroclor 1260 only from a method detection limit study performed by Golder Associates, Inc., using ground-water samples from a monitoring well at the GE-Spokane site. Sample PQLs are highly matrix-dependent and may not always be achievable.

FIGURES

WP/CMP1/CMP1-008-A
9/2/93



EXPLANATION

- Planned Excavations
- Estimated Extent of Subsurface PCB-Containing Soils Above Cleanup Levels
- Volume Reduction Fines
- GE Property Line

NOTES:

- 1) The ISV slope backfill is assumed to be PCB-containing. This will be confirmed by additional sampling prior to the cleanup action design.

Bechtel SAN FRANCISCO			
GENERAL ELECTRIC/SPOKANE			
CONCEPTUAL SITE LAYOUT FOR EXCAVATION			
	Job Number	Drawing No.	Rev.
	19099	FIGURE 4-1	A

93-2442b.003 7-15-93 m/s:6
REV'da 8/17/93

APPENDIX A

HYDROSTAR

GROUND WATER SAMPLING PUMP

**HS8000
AND
HS8001
OPERATIONS MANUAL**



Instrumentation Northwest, Inc.

14972 NE 31st Circle
Redmond, WA 98052

(206) 885-3729 • (800) 776-9355 • FAX (206) 867-0404



HydroStar Operations Manual

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II. Manual Handle Installation & Operation	1
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Appendix B - Air Motor Specifications	8

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I. First Things First

Please read through this manual completely if you are not familiar with the operation of the HydroStar. If at any point you have difficulties, please call Instrumentation Northwest, Inc. at (206) 885-3729.

Before attaching your operating tool (either a manual handle or an air motor), check the package and contents for damage. If damage appears, file a claim with the carrier immediately. Contact Instrumentation Northwest before returning any equipment.

II. Manual Handle Installation and Operation - Above Ground Completion

The following paragraphs and drawings describe how to install the manual handle assembly to your HydroStar well seal and pump.

Step 1

Insert the manual handle support into the motor mount located on the well seal assembly. Be sure at least two (2) holes on the manual handle support intersect with two (2) holes in the motor mount. To achieve the best mechanical leverage, place the bolt on the cam approximately 36" above ground level.

Step 2

Slide your clevis pin through one of the intersecting holes on the manual handle support. Place your hitch pin through the hole in the small end of the clevis pin to lock it.

Step 3

Attach the wire rope assembly to the turnbuckle assembly on the top of the well seal by putting the clevis pin in place. Put a hitch pin through the hole at the small end of the clevis pin to lock it.

Step 4

Feed the end of the wire rope through the manual handle shackle. Be sure the wire rope is resting in the slot of the cam. Lift the handle so that the flat edge of the cam nearest to the shackle is parallel with the ground. Pull out all slack. Tighten the shackle until the wire rope is secure. (See Figure 1 on following page)

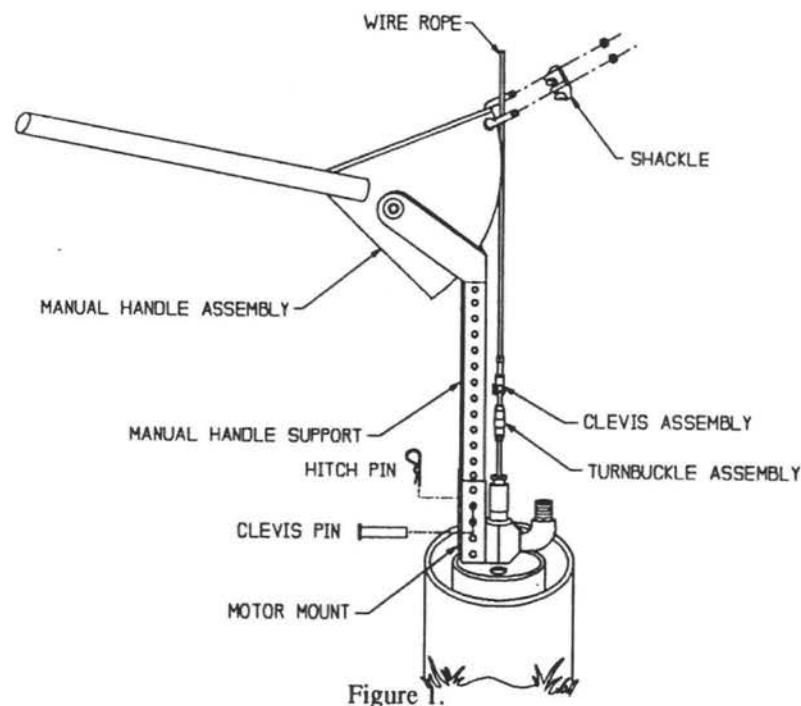


Figure 1.

Step 5

The pump is now ready to be operated. Depending on your requirements, attach either the purge hose (large diameter), or the sampling hose (small diameter) to the discharge outlet on the well seal.

Step 6

Begin pumping the manual handle with smooth, even strokes. For best performance, use 20 to 45 strokes per minutes for purging and 1 to 5 strokes per minute for sampling.

III. Manual Handle Installation and Operation - Flush Grade Completions

Step 1

Attach the extension brace with the clevis and hitch pins to the manual handle support (Figure 2 on following page).

Step 2

Adjust the height and leg length accordingly for ease of operation.

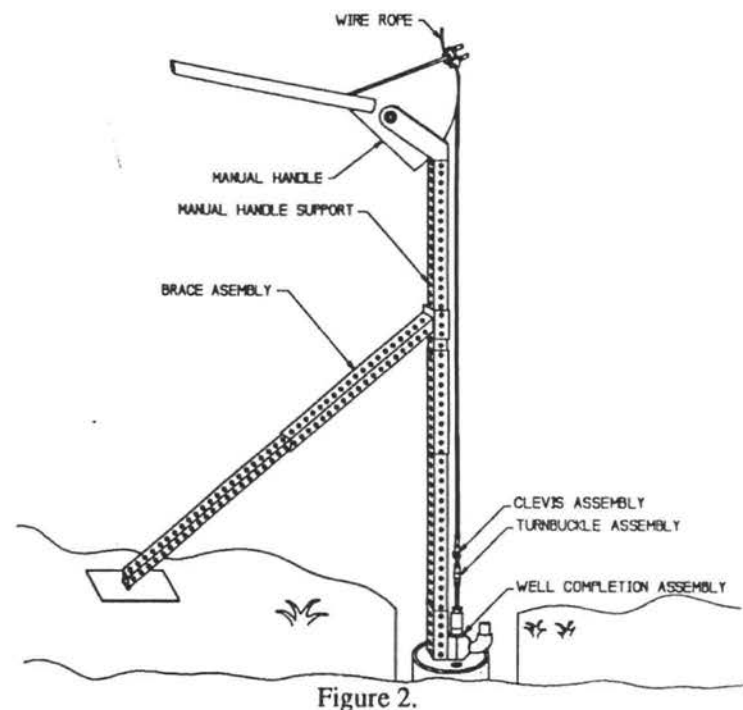


Figure 2.

Step 3

Repeat steps 1-6 in "I. Manual Handle - Above Ground Completion".

IV. Attaching and Operating the Automatic Motor Assembly

Step 1

Insert the pneumatic motor support into the motor mount on the well seal. Be sure at least two (2) holes intersect on the motor support and the motor mount. (See Figure 3 on following page.)

Step 2

Slide a clevis pin through one of the intersecting holes and secure with a hitch pin.

Step 3

Pull the cylinder ram all the way out. This ram **MUST** be extended completely.

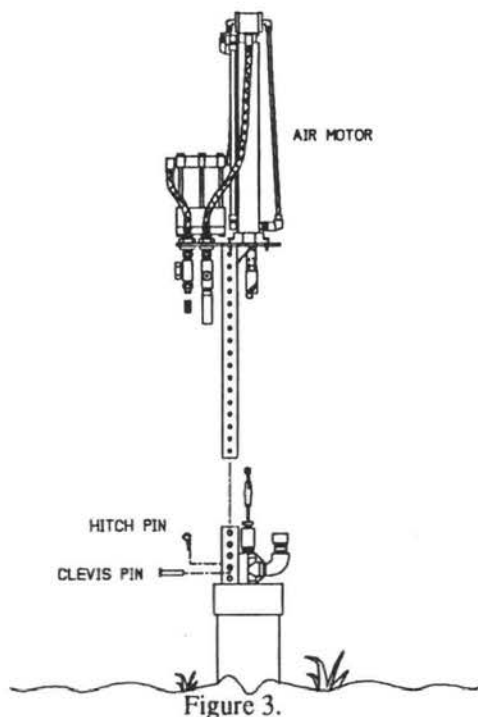


Figure 3.

IMPORTANT NOTE: It is possible to break the stainless steel spring inside the pump body during the downward stroke of the ram on the air motor. This will cause metal fatigue and will eventually break the spring. This can be avoided by following this step prior to making the final attachment of the rod to the air motor ram. To prevent this, you can "pretension" the pump spring by raising the rod 1/4" to 1/2" and then connecting the turnbuckle to the air motor ram using the clevis and hitch pins. This will insure that the air motor ram will not force the pump spring down onto itself at the completion of the downward stroke of the ram.

Step 4

Adjust the turnbuckle assembly to the appropriate height as previously outlined. Secure the turnbuckle in place with the locking clip and jam nut.

Step 5

It is recommended that the turnbuckle assemblies remain with the pump assembly to avoid adjustment every time the pump needs to be operated.

Step 6

The pump is now ready for operation. Refer to Appendix B - Air Motor Specifications to determine the proper compressor size for your installation. (Figure 4)

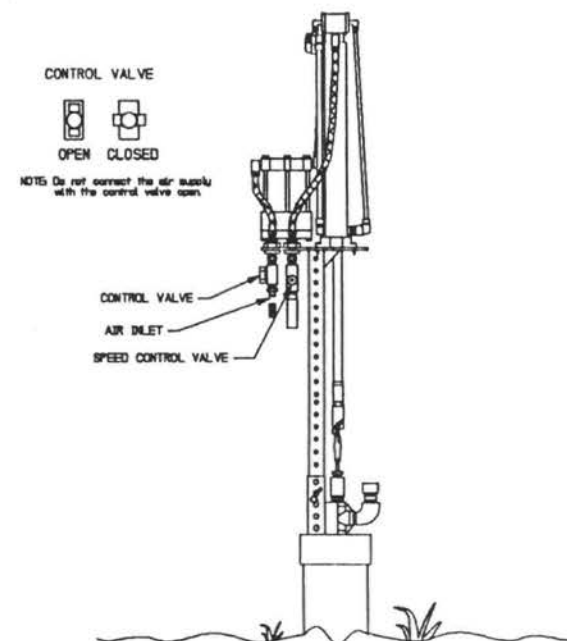


Figure 4.

Step 7

Make sure the control valve is closed.

Step 8

Attach the air supply to the air motor via the quick connect.

Step 9

Turn on your air supply to the control valve.

Step 10

Open the control valve, the motor will begin pumping.

Step 11

The stroke speed of the cylinder can be adjusted by the speed control valve located just above the nylon muffler.

Appendix A - Pump Specifications

The HydroStar HS8000 and HS8001 are both designed for ground water sampling.

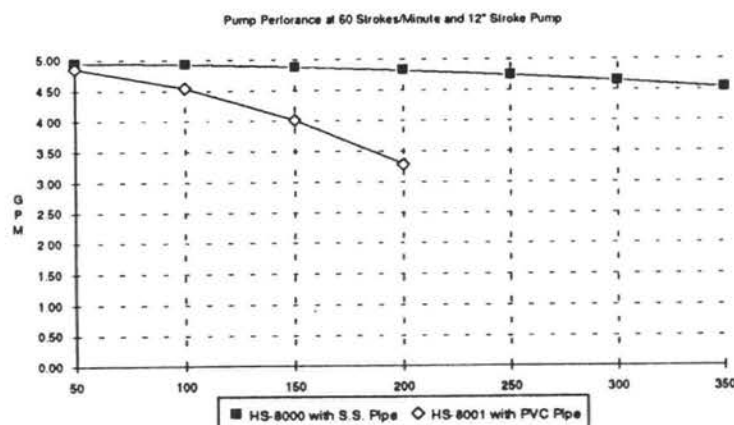
NOTE: The HS8001 can also be operated with a production seal kit for production applications which add heavy duty seals to the pump for continuous pumping. Adding the production seal kit will preserve the life of the HS8001 pump but adds viton or polyurethane parts which may affect certain types of sampling requirements.

The following depth rating chart shows the available selections:

Depth Rating	Pump	Rod Size	Pipe Material	Stroke Length
0-150'	HS8000	1/4"	3/4" PVC	12"
0-150'	HS8000	1/4"	3/4" SS	12"
0-350'	HS8001	1/4"	3/4" SS	12"

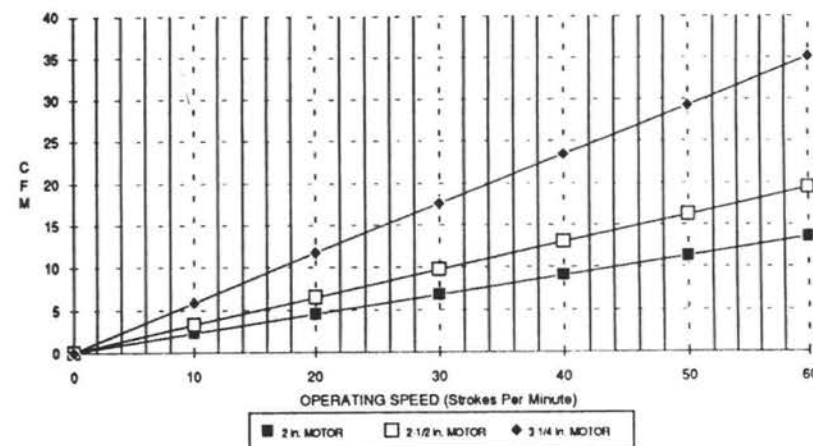
Other models of HydroStars are available for deeper applications. Please call us.

Pump Performance Curve:



Air Consumption Curve:

(nominal pump production per stroke = 0.0825 gallons)



Determining Maximum Pump Performance

Step 1

Determine the capacity of the air compressor available to you

Step 2

Using the air consumption curve, determine the maximum operating speed of your air motor.

Step 3

Multiply the pump production per stroke (0.0825) by the stroke rate to determine the pump performance.

NOTE: When using an air driven system, a number of other factors may effect the performance of your pump. INW does not guarantee that your system will always perform to the specifications listed above. However, our systems have been fully tested and inspected. If you have troubles achieving the performance specified, please contact our service department at (206) 885-3729.

Appendix B - Air Motor Specifications

Air Motor Specification Chart

Cylinder Size	Max Stroke Rate	Max Full Speed Depth	Air Consumption*
2" x 12"	60	150'	10.8 SCFM
2.5" x 12"	60	250'	16.5 SCFM
3.25" x 12"	60	400'	29.4 SCFM
Manual Handle	40	150'	NONE

Compressor Selection

Choose a compressor that has a FREE AIR CFM rating equal to the maximum air consumption required for your air motor. If a compressor of this size is not available, no harm will be done the system but it will NOT operate at full speed. Refer to the air consumption curve to determine the actual performance of your air compressor.

Freeze-up Considerations

All HydroStar system air motors now come with an air dryer/separators which will minimize freeze-up problems. If you are having problems with stalled motors due to freezing valves, a lubricator can be added to the system that will inject anitfreeze lubricants into the valves. Contact INW for acceptable anti-freeze solutions.

Questions?

If at any time, you have any questions regarding this product, please call us:

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GE-SPOKANE REMEDIAL DESIGN/REMEDIAL ACTION PROJECT

COMPLIANCE MONITORING PLAN
PART 3

SOIL-GAS SAMPLING AND ANALYSIS PLAN

Prepared for

GENERAL ELECTRIC COMPANY

by

BECHTEL ENVIRONMENTAL, INC.

San Francisco, California

December 1993



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Tables (in section following text)

1-1	Cross-Reference to Consent Decree Requirements
3-1	Soil-Gas Sampling and Measurement Parameters

Figures (in section following tables)

3-1	ISV Test Cell Layout and Planned Soil-Gas Monitoring Well Locations
5-1	Soil-Gas Monitoring Well Design

Section 1

INTRODUCTION

This Soil-Gas Sampling and Analysis Plan was prepared by Bechtel Environmental, Inc. (Bechtel), for General Electric Company (GE) as Part 3 of the Compliance Monitoring Plan. The Compliance Monitoring Plan is one of the Project Plans for the GE-Spokane Remedial Design/Remedial Action (RD/RA) Project, as required under the *Consent Decree (WDOE, 1993b)* between GE and the Washington Department of Ecology (WDOE). This plan presents the objectives and procedures for monitoring soil gas during the In Situ Vitrification (ISV) Demonstration Test, which is to be performed at the GE-Spokane site as part of the RD/RA activities.

Section 2 of this plan presents the sampling objectives, including how action levels triggering additional sampling or mitigative measures will be calculated. Section 3 presents sampling locations and frequency. Section 4 discusses sample designation and Section 5 discusses sampling equipment and methods. Table 1-1 provides a cross-reference indicating where the Consent Decree requirements are addressed in this plan.

The RD/RA project is described in detail in the foreword to the Compliance Monitoring Plan. References cited in this plan are provided at the end of the Compliance Monitoring Plan. Quality assurance/quality control procedures for the soil-gas monitoring are presented in the Quality Assurance Project Plan, which is Part 4 of the Compliance Monitoring Plan.

Section 2

SAMPLING OBJECTIVES

The objective of the soil-gas sampling and analysis program is to determine whether there is outward migration of gases or vapors through the subsurface during the planned ISV Demonstration Test. The ISV Demonstration Test is intended as a treatability test of the ISV technology. If it is successful, the technology will be used for cleanup of site soils. The ISV technology involves melting of soil, through the application of electrical energy, to pyrolyze organic chemicals and immobilize inorganic chemicals. The ISV technology is described in more detail in the Summary Cleanup Action Planning Report and the *Report of the ISV Demonstration Test Preparation Activities* (Bechtel, 1991b). For the demonstration test, the soils to be treated have been staged in five subsurface (presently 19 feet deep) test cells. The test cell depth will be reduced to 16 feet as part of the test cell modifications described in the Soil Treatment Plan.

The many previous tests of the technology performed by Geosafe, the vendor, and others, have indicated that there is little or no outward migration of chemical vapors through the soil from the ISV melt zone (Geosafe, 1990). The gases and vapors generated during the process are expected to migrate to the ground surface, where they are captured by a hood under negative pressure and treated. WDOE, however, requires monitoring of soil gas during the demonstration test as part of the RD/RA compliance monitoring.

The general approach to the soil-gas monitoring will consist of installation of three soil-gas monitoring wells around the ISV test cell area, conducting baseline monitoring (prior to the demonstration test) and conducting monitoring during the demonstration test. Soil-gas pressure will be the indicator parameter for monitoring. If positive soil-gas pressures are detected during the ISV processing, samples of the soil gas will be collected and analyzed for ISV combustion products.

WDOE has requested that action levels triggering additional sampling or mitigative measures be established in this plan. The action level will be a statistically significant increase in soil-gas pressure. Because background soil-gas pressure values and trends have not been established, it is necessary to perform baseline monitoring (see Section 3.2.1) to establish this action level. After collecting the baseline data and calculating the action level, the proposed action level, the supporting data, and the calculation will be presented to WDOE in a technical memorandum for review.

Section 3

SAMPLE LOCATIONS AND FREQUENCY

This section provides the proposed sampling locations and frequency for the soil-gas monitoring program.

3.1 Sampling Locations and Depth

Planned locations for the three soil-gas monitoring wells are provided in Figure 3-1. The general locations were selected such that the wells will be evenly spaced around the test cell area, will monitor processing of a variety of cell configurations (cells 1, 2 and 4), will avoid areas where PCBs are currently present in soils, and will be far enough away from the cells to minimize interference with the ISV operations.

The ISV test cells were originally constructed with concrete exterior walls. These walls, however, will be ruptured to minimize buildup of vapors in the melt zone. The wall ruptures will allow vapor to pass through the walls and up through the zone outside of the walls, where they will be captured by the hood. The exact locations of the soil-gas monitoring wells will coincide with the locations of the wall ruptures to ensure that they are positioned near the potential escape pathways. The soil-gas monitoring wells will be eight feet deep. This depth was selected because it is approximately the midpoint of the proposed melt zone, which is the widest part of the melt, and therefore most likely to detect migrating vapors.

3.2 Sampling Frequency

This section describes the sampling frequency for the monitoring to be conducted before and during the ISV Demonstration Test. Sampling frequency and other parameters are summarized in Table 3-1.

3.2.1 Pre-Test Monitoring

During the pre-test monitoring, soil-gas pressure and subsurface temperature readings will be taken every hour, 24 hours per day, for one week at each well. Atmospheric pressure will also be measured hourly at a central location on site.

3.2.2 Monitoring During ISV Demonstration Test

Pressure and temperature measurements will be collected at the same frequency during the ISV Demonstration Test as during the baseline monitoring, that is, every hour. The data will also be manually queried every four hours. This monitoring will continue during the entire melting period for cells 1, 2, and 4.

If a positive pressure above the action level is measured, collection of a sample for chemical analysis will be initiated immediately. One sample will be collected from each well showing soil-gas pressure above the action level. If samples from the wells are needed, one duplicate (collected simultaneously) and one ambient air blank will also be collected.

Section 4

SAMPLE DESIGNATION

The soil-gas monitoring wells will be designated SG-1, SG-2, and SG-3. Samples collected for chemical analysis will be designated by the well number followed by a numerical suffix indicating the chronological order of sample collection (e.g., SG-1-1 would represent the first sample from well SG-1). Blank and duplicate samples will be designated with an unused well number, such as SG-4, so that they will be "blind" to the analytical laboratory.

Section 5

SAMPLING EQUIPMENT AND PROCEDURES

This section describes the sampling equipment and procedures to be used in the soil-gas monitoring program.

5.1 Sampling Devices

The soil-gas monitoring well design is shown in Figure 5-1. The wells will be installed in 6-inch diameter boreholes drilled using the air-rotary/casing hammer method. The wells will be constructed of 1-inch diameter PVC screen and riser. The screens will be 1-foot long, mill-slotted (0.020-inch), and surrounded by a coarse sand filter pack. The remainder of the annular space will be filled with cement grout.

The top of the riser casing will be fitted with a check valve, a solid state pressure transducer, a valved soil-gas sampling port, and a leak testing port. A thermocouple will be placed in the well screen and the lead will exit the wellhead through a sealed port. The wellhead will be protected with a steel casing cemented in place.

After installation of the wellhead fittings and instrumentation, the system will be leak-tested by inducing positive pressure in the wellhead through pumping outside air through the leak testing port. Soap film will be used to check the seals around the sampling port, thermocouple fitting and pressure transducer. After completion of the leak testing, the leak testing port will be sealed with a solvent-welded PVC cap.

Equipment for the collection of samples for chemical analysis will include a sorbent cartridge connected via 1/4-inch diameter polytetrafluoroethylene (PTFE) tubing to a sampling pump and a totalizing air flow meter. Ambient air blank samples will be collected with an identical apparatus, but fitted with a dust filter, which will be open to ambient air in an area away from the ISV test cells. Duplicate samples will be

collected by placing a splitter (tee fitting) on the sample port of one well, with duplicate sorbent cartridges and flow meters.

Sample volumes, containers and holding times are summarized on Table 3-1.

5.2 Field Measurement Procedures

Soil-gas pressure and temperature measurements and barometric pressure measurements will be taken and recorded automatically with an electronic data logger.

5.3 Soil-Gas Sampling Procedures

During the demonstration test, each soil-gas monitoring well will be equipped with a sorbent cartridge, sampling pump, and totalizing air flow meter so that sampling may be initiated immediately upon detection of a positive pressure above the action level. Soil-gas samples will be collected by opening the valve to the sampling port and pumping the soil gas through the sorbent cartridge. The air flow will be measured with a totalizing flow meter. Upon achieving the required volume of air flow through the cartridge, the cartridge will be removed, resealed in its pre-cleaned foil container and placed in a pre-cleaned glass sample jar. The sample will be held at 4°C until, and during, shipment to the analytical laboratory.

After completion of the soil-gas monitoring program, the soil-gas monitoring well PVC casings will be removed and the borings will be abandoned by backfilling with cement grout.

TABLES

TABLE 1-1

CROSS-REFERENCE TO CONSENT DECREE REQUIREMENTS

<i>Consent Decree Requirement</i>	<i>SGSAP Section</i>
Sample locations.	3.1
Sampling procedures and method of analysis.	5
List of parameters to be measured.	Table 3-1
Action levels triggering additional sampling or mitigative measures.	2
19099	12/20/93

TABLE 3-1

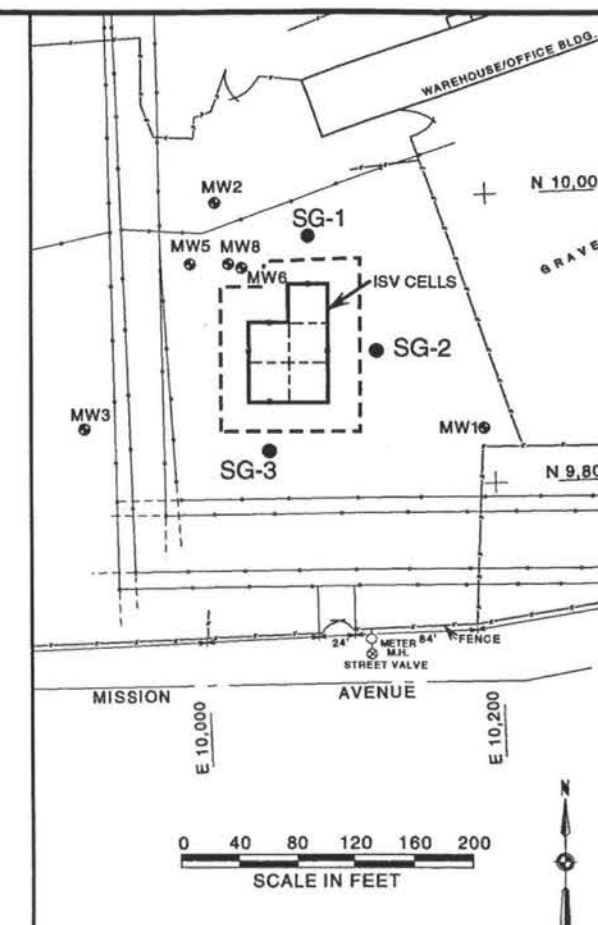
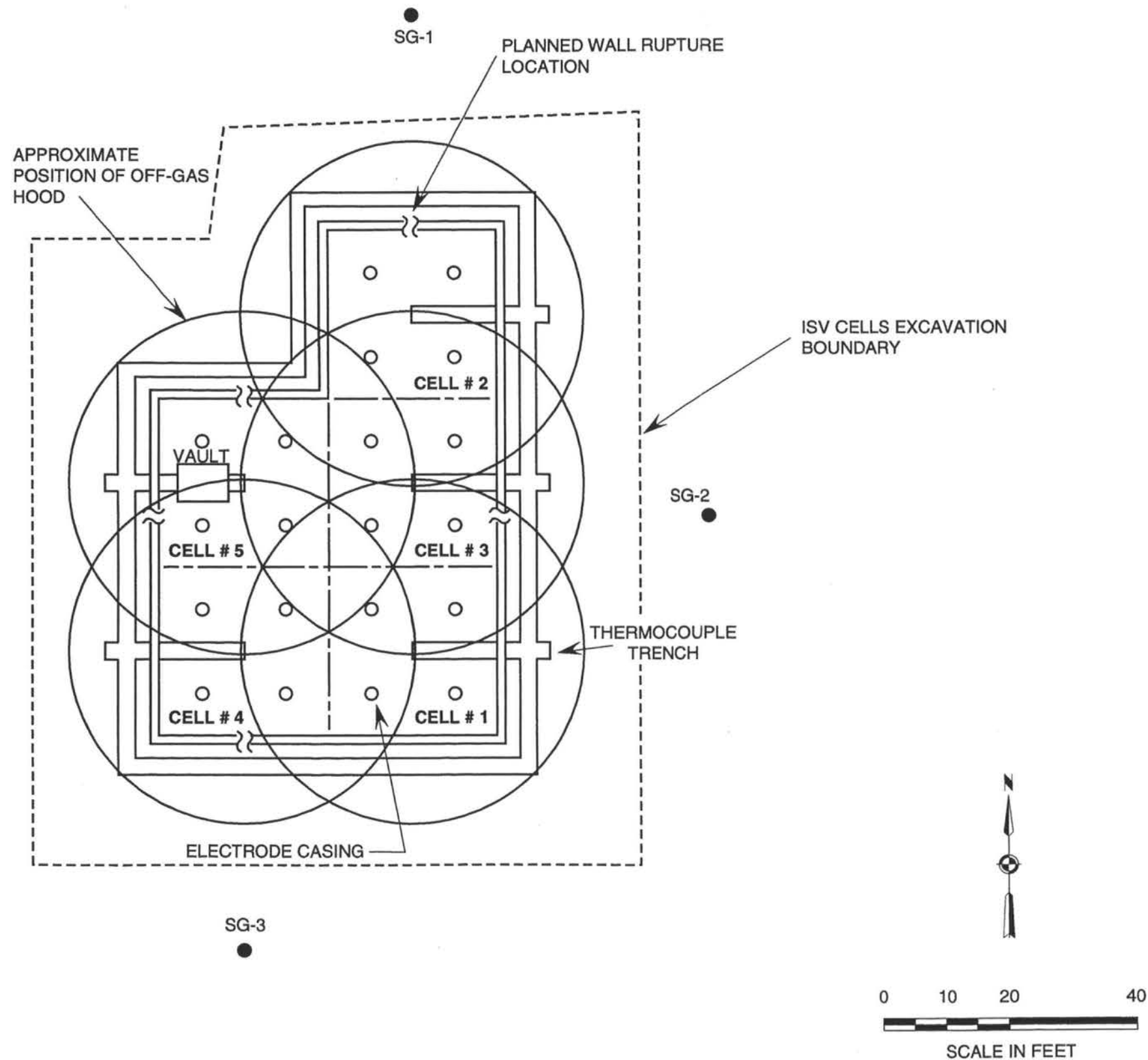
SOIL-GAS SAMPLING AND MEASUREMENT PARAMETERS

<i>Parameter</i>	<i>Units</i>	<i>Frequency</i>		<i>Volume</i>	<i>Container</i>	<i>Holding Time</i>
		<i>Pre-Test</i>	<i>During Test</i>			
Soil-Gas Pressure	psi	hourly	hourly (1)	N/A	N/A	N/A
Atmospheric Pressure	psi	hourly	hourly	N/A	N/A	N/A
Temperature (Downhole)	Degrees C	hourly	hourly	N/A	N/A	N/A
Combustion Products	µg/m ³	N/A	1 per well (2)	300 L	Sorbent Cartridge	21 days
Duplicate	µg/m ³	N/A	1	300 L	Sorbent Cartridge	21 days
Ambient Air Blank	µg/m ³	N/A	1	300 L	Sorbent Cartridge	21 days

(1) Queried manually every 4 hours during each melt period for cells 1, 2 and 4.

(2) Combustion products will be analyzed if positive soil-gas pressure above action level is detected.
The action level will be determined after baseline monitoring.

FIGURES



KEY PLAN

EXPLANATION

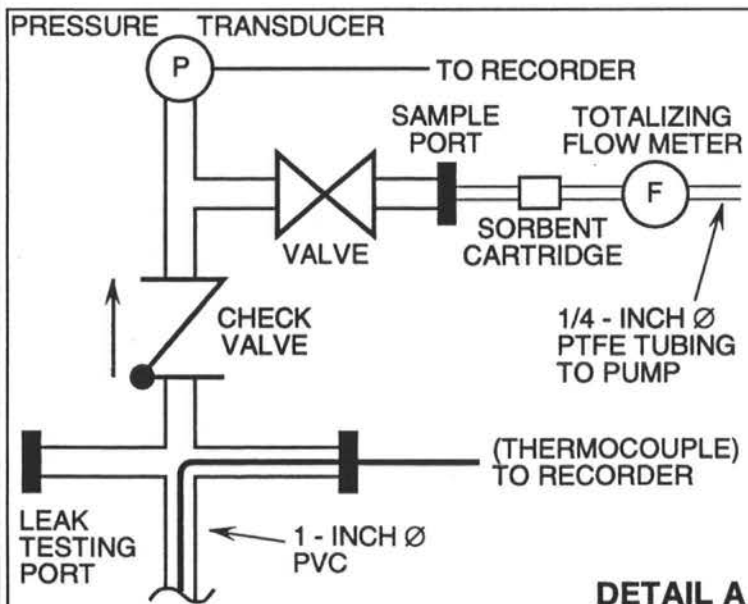
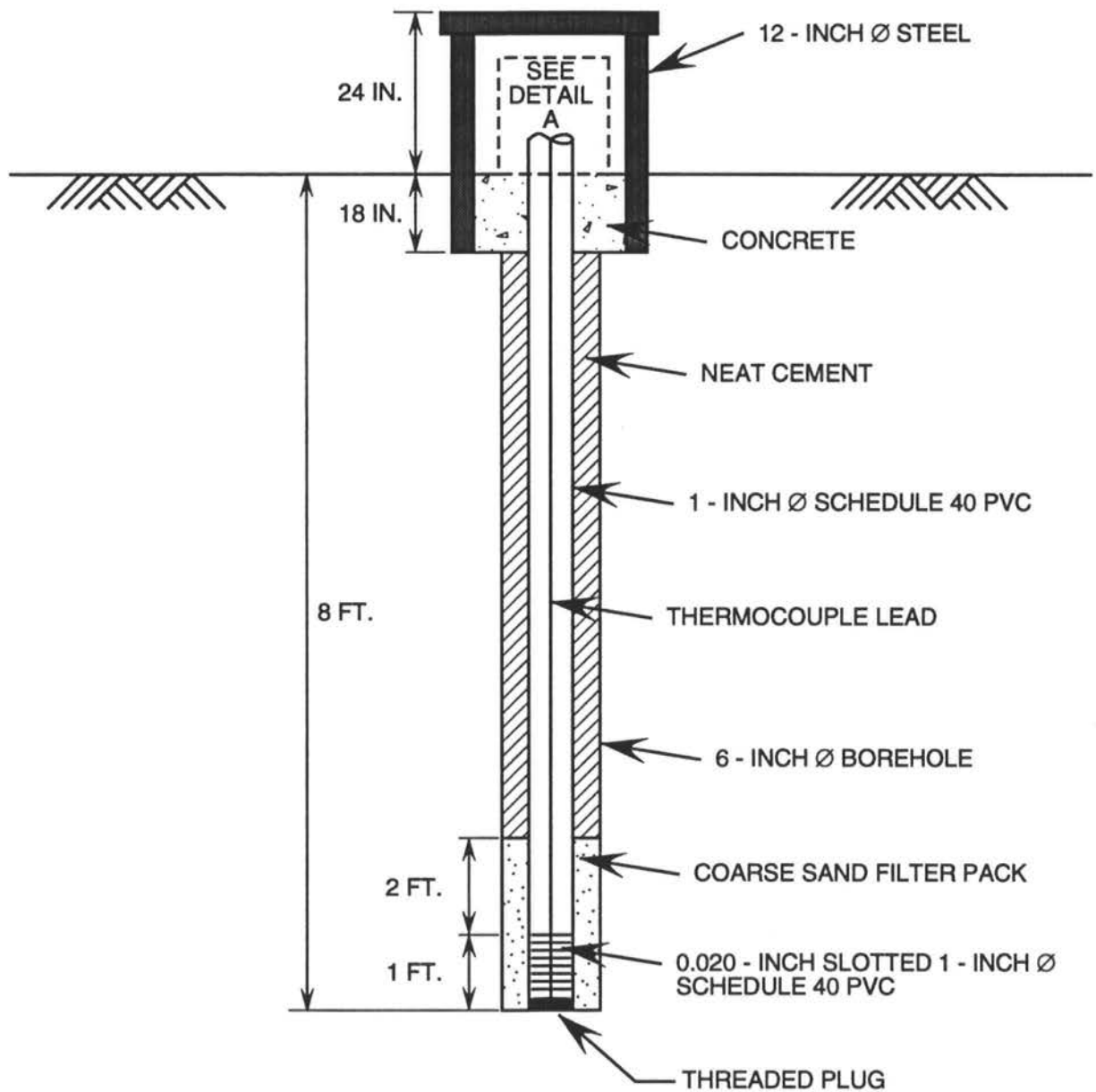
- Proposed soil gas monitoring well (exact locations to coincide with wall ruptures)

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SAN FRANCISCO

GENERAL ELECTRIC/SPOKANE

ISV TEST CELL LAYOUT AND PLANNED SOIL GAS MONITORING WELL LOCATIONS

Job Number	Drawing No.	Rev.
19099	FIGURE 3-1	A



NOT TO SCALE

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GENERAL ELECTRIC/SPOKANE

SOIL GAS MONITORING WELL DESIGN



Job Number

19099

Drawing No.

FIGURE 5-1

Rev.

C

GE-SPOKANE REMEDIAL DESIGN/REMEDIAL ACTION PROJECT

COMPLIANCE MONITORING PLAN
PART 4

QUALITY ASSURANCE PROJECT PLAN

Prepared for

GENERAL ELECTRIC COMPANY

by

BECHTEL ENVIRONMENTAL, INC.

San Francisco, California

December 1993



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Section 1

INTRODUCTION AND PROJECT ORGANIZATION

This Quality Assurance Project Plan was prepared for General Electric Company (GE) by Bechtel Environmental, Inc. (Bechtel) as Part 4 of the Compliance Monitoring Plan. The Compliance Monitoring Plan is one of the Project Plans for the GE-Spokane Remedial Design/Remedial Action (RD/RA) Project, as required under the (WDOE, 1993b) between GE and the Washington Department of Ecology (WDOE). This Quality Assurance Project Plan provides procedures for making accurate measurements and obtaining representative, accurate, and precise analytical data.

The remainder of Section 1 discusses the scope and applicability of this Quality Assurance Project Plan and describes the data management team organization and responsibilities. Data quality objectives are discussed in detail in Section 2. Sampling and analytical procedures are discussed in Section 3 and custody procedures are discussed in Section 4. Sections 5 and 6 discuss decontamination and calibration procedures. Data reduction, validation, documentation and reporting are discussed in Section 7. Quality control checks, routine data quality assessment procedures and audit requirements are discussed in Sections 8, 9 and 10, respectively. Sections 11, 12 and 13 address preventative maintenance, corrective action and quality assurance reports. Table 1-1 provides a cross-reference indicating where the Consent Decree requirements are addressed in this plan.

Other Project Plans which contain information related to that in this Quality Assurance Project Plan include:

- Summary Cleanup Action Planning Report;
- Soil Sampling and Analysis Plan, which is Part 1 of the Compliance Monitoring Plan;
- Ground-Water Sampling and Analysis Plan, which is Part 2 of the Compliance Monitoring Plan;

- Soil-Gas Sampling and Analysis Plan, which is Part 3 of the Compliance Monitoring Plan;
- Health and Safety Plan;
- Data Management Plan; and
- Investigation and Project Waste Management Plan.

The three Sampling and Analysis Plans contain sampling and analysis procedures specific to each medium. Air sampling and analysis procedures are provided in the HSP.

The Data Management Plan provides procedures for the statistical analysis of data to evaluate compliance with cleanup levels.

The Investigative and Project Waste Management Plan provides requirements for management of residuals from the decontamination procedures (and other project activities) outlined in this Quality Assurance Project Plan.

The Summary Cleanup Action Planning Report provides an overview of the project, organizational details, and schedule.

1.1 Scope and Applicability

This Quality Assurance Project Plan addresses compliance monitoring activities for soil, ground water, soil gas, and air as specified in the *Consent Decree (WDOE, 1993b)*. The procedures in this Quality Assurance Project Plan apply to the following sampling and analysis activities:

- Soil cleanup action samples described the Soil Sampling and Analysis Plan, including excavation samples, cobble samples, backfill samples, samples to confirm placement of grout, and treated soil samples.
- Ground-water measurements and samples as described in the Groundwater Sampling and Analysis Plan;

- Soil-gas measurements and samples as described in the Soil-Gas Sampling and Analysis Plan; and
- Air measurements and samples as described in the Health and Safety Plan.

1.2 Data Management Team Organization and Responsibilities

The overall project organization is shown in Figure 1-5 of the Summary Cleanup Action Planning Report and the organization of the data management team is shown on Figure 1-1 of this Quality Assurance Project Plan. The responsibilities of the key data management personnel are as follows:

Project Environmental Scientist

The Project Environmental Scientist reports to the Project Scientist. The Project Environmental Scientist is responsible for planning and executing all environmental sampling and analysis for compliance monitoring. The Project Environmental Scientist is responsible for preparation of analytical data reports, including submittals to WDOE, in conjunction with the Data Coordinator. The Project Environmental Scientist prepares the specifications for, and administers the subcontracts for laboratory analysis.

Data Manager

The Data Manager reports to the Project Environmental Scientist. The Data Manager is responsible for all aspects of data management including tracking of analytical data generated during the cleanup action, oversight of the project database, preliminary data evaluation, checking of data reduction calculations and overall data validation.

Data Coordinator

The Data Coordinator reports to the Data Manager. The Data Coordinator is responsible for coordinating with the onsite and offsite laboratories to obtain required analyses. The Data Coordinator is responsible for sample tracking, chain of

custody, and other sampling and analysis documentation. The Data Coordinator maintains the data center files, including tabulating, compiling and archiving data. The Data Coordinator is responsible for the review of onsite laboratory analysis reports. The Data Coordinator is responsible for assembly, organization and maintenance of all information collected during field activities (including sampling logbook, daily activity logbook, geologic boring logs, chain-of-custody forms, well construction details, and water-level measurements).

Database Manager

The Database Manager reports to the Data Manager. The Database Manager is responsible for setting up the project database, designing and formatting data tables, preparing customized data reports, entering essential information, troubleshooting, and maintenance of the database.

Field Sampling Personnel

The Field Sampling Personnel report to the Project Environmental Scientist. The Field Sampling Personnel are responsible for collecting all field samples.

Section 2

DATA QUALITY OBJECTIVES

This Quality Assurance Project Plan was developed to ensure that the quality and quantity of the analytical data obtained during the GE-Spokane RD/RA project are sufficient to support the intended uses of the data. The quality of data obtained from sampling and analysis must also be sufficient to show compliance with Model Toxics Cleanup Act (MTCA) requirements in *Washington Administrative Code (WAC) 173-340*.

Data Quality Objectives (DQOs) are an integral part of the planning process for each stage of the project. This section defines DQOs and presents the specific DQOs developed to ensure that appropriate data are collected in sufficient quantity and quality to meet project needs.

2.1 Definition of Data Quality Objectives

Measurement and analytical data obtained from site sampling will be used to evaluate if the site has attained required cleanup levels. Based upon the nature of the data collection activities, various DQO decisions are made. Among the data quality objectives needed to ensure that data are collected in sufficient quality and quantity for the decisions to be made are:

- The specification of detection limit requirements;
- The identification of the appropriate analytical support level requirements based on the intended uses of the data;
- Selection of the appropriate levels of precision, accuracy, representativeness, completeness, and comparability (PARCC) for the data; and
- The identification of the level of confidence needed in the data.

Each of these elements impacts the degree of control placed over the collection and analysis of the data as follows:

- The required detection limits impact the methods used for analysis;
- The analytical support levels impact the quantity of quality control (QC) samples and the extent of documentation and data validation;
- The PARCC parameters selected impact the kind of QC samples appropriate to the sampling process; and
- The desired level of confidence impacts the statistical approach used to collect samples (quantity and spatial distribution) and to evaluate the analytical results from the samples.

These DQO requirements are defined in the following sub-sections, then specific DQOs for the RD/RA project are identified in Section 2.2.

2.1.1 Detection Limits

The cleanup levels selected by WDOE directly affect the data quality requirements. Therefore, it is important that the analytical methods chosen have detection limits well below the cleanup levels. Different types of detection limits which may be adopted are defined below.

Method Detection Limit (MDL) - The MDL is the minimum amount of an analyte that can be routinely identified using a specific method.

Contract Required Detection Limit (CRDL) - The CRDL is the lower limit for confident quantitation within the defined linear ranges of required calibration procedures.

Practical Quantitation Limit (PQL) - The PQL, defined in *U.S. EPA, 1986*, is the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Regardless of the specified *method* detection limit, the *actual* detection limit reported may be sample-specific. This is especially true of samples having complex matrices (i.e., samples containing numerous analytes at widely different concentration ranges).

2.1.2 Analytical Support Levels

The analytical support levels are chosen based upon the intended uses of the data. *Data Quality Objectives for Remedial Response Activities (U.S. EPA, 1987a)* provides the guidance for selecting appropriate analytical support levels based on the intended use of the data. The analytical support levels are defined as follows.

Level I - Field screening. This level is characterized by the use of portable instruments which can provide real-time data to assist in the optimization of sampling point locations and for health and safety monitoring. Data can be generated regarding the presence or absence of certain contaminants at sampling locations.

Level II - Field analysis. This level is characterized by portable analytical instruments which can be used onsite, or in mobile laboratories stationed near a site. Depending upon the sample matrix, analytes, and personnel skills, qualitative and quantitative data can be obtained.

Level III - This level uses laboratory methods other than Contract Laboratory Program (CLP) Routine Analytical Services (RAS). This level is used primarily in support of studies using standard U.S. EPA approved procedures. Some procedures may be equivalent to CLP RAS without the CLP requirements for documentation.

Level IV - This level uses CLP RAS. This level is characterized by rigorous QA/QC protocols and documentation and provides qualitative and quantitative analytical data.

Level V - This level uses non-standard methods, or methods which may require modification and/or development.

Analytical support levels appropriate to data uses are provided in Table 2-1 (U.S. EPA, 1987a).

2.1.3 Precision, Accuracy, Representativeness, Completeness, and Comparability Criteria

The precision, accuracy, representativeness, completeness, and comparability parameters are indicators of data quality and are defined as follows (U. S. EPA, 1987a):

Precision - Precision examines the spread of the reported values about the mean. It is a measure of the reproducibility of measurements under a given set of conditions. Precision is usually reported in terms of relative percent difference (RPD) and/or relative standard deviation.

Accuracy - Accuracy is the degree of agreement of a measurement with an accepted reference or true value, i.e., bias. Accuracy measures the average or systematic error of a method. Accuracy is commonly determined from spiked samples and is reported as percent recovery.

Representativeness - Representativeness is a qualitative parameter which expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is addressed by describing sampling techniques and the rationale used to select sampling locations.

Completeness - Completeness is the amount of valid data obtained from a measurement system compared to the amount that was expected and needed to meet the project data goals.

Comparability - Comparability is a qualitative parameter which expresses the confidence with which one data set can be compared to another.

2.1.4 Level of Confidence

According to MTCA [*Washington Administrative Code (WAC) 173-340-740(7)(d)(i)*] (WDOE, 1990), the appropriate statistical method for evaluating compliance with cleanup levels based on chronic or carcinogenic effects is to compare the upper confidence limit (UCL) of the mean of the sample concentrations. MTCA (WAC 173-340-200) (WDOE, 1990) specifies that the null hypothesis for evaluating compliance is that chemical concentrations at the site exceed the cleanup level. Since there is only one possibility for the alternative hypothesis (chemical concentrations do not exceed cleanup levels), the upper confidence limit is one-sided. Thus, the one-sided upper confidence limit of the mean is the level to which the cleanup levels will be compared.

The upper confidence limit is defined as $100 \times (1-\alpha)$. The statistical parameters to be used to calculate the upper confidence limit are: α , the false positive rate or Type I error and the confidence limit. The false positive rate is the rate at which the site may be assumed clean when in fact it is not. The specific parameters to be used for the GE-Spokane project are discussed in Section 2.2.4.

2.2 Project-Specific Data Quality Objectives

The specific DQOs for the RD/RA project are defined in this subsection.

2.2.1 Detection Limits

Detection limits appropriate for soil, ground water, soil gas, and air analyses are discussed below.

2.2.1.1 Soil

Contract Laboratory Program Routine Analytical Services detection limits will be sufficiently below cleanup levels for polychlorinated biphenyls (PCBs) and total petroleum hydrocarbons. Therefore, the contract required detection limit specified for CLP RAS Method 8080, 0.033 mg/kg, will be used for the analysis of PCBs. (The cleanup level for PCBs is 10 mg/kg for soils 15 feet or less below ground surface and 60 mg/kg for soils greater than 15 feet below ground surface.) The contract required detection limit of 10 mg/kg for the analysis of TPH using U.S. EPA Method 418.1 is also sufficiently below the cleanup level (200 mg/kg) and is therefore appropriate for the project DQOs.

2.2.1.2 Ground Water

Ground-water samples will be analyzed for PCBs using CLP Special Analytical Services (SAS) with a modified extraction method as outlined in *U.S. EPA Manchester Laboratory SOP for Extraction of BNAs/PEST/PCB/OP-PEST in Water* (U. S. EPA Manchester Laboratory, 1991). Modifications to the extraction method include:

- Extraction of a 3-liter sample volume instead of 1 liter;
- Extraction using a stir-bar method; and
- Concentration of sample to a final volume of 1 mL.

With this method, a practical quantitation limit of 0.05 µg/L is expected to be achievable, as was obtained in a method detection limit study performed by Golder Associates (*Golder, 1992a*) using ground water from well MW-12 subjected to the modified extraction method.

Ground-water samples will be analyzed for total petroleum hydrocarbons (TPH) and volatile organic compounds (VOCs) on an annual basis to track migration of any hydrocarbon compounds which may influence PCB concentrations. Contract required detection limits for CLP RAS volatile organic compounds will be sufficient for these analyses.

2.2.1.3 Soil Gas

Appropriate detection limits for combustion gas parameters will be determined after specific combustion parameters to be tested have been identified.

2.2.1.4 Air

Air sampling will be performed as described in the Health and Safety Plan. The air analysis methods selected are standard National Institute of Occupational Safety and Health methods, which all have method detection limits below the applicable Washington Industrial Safety and Health Administration permissible exposure limits.

2.2.2 Analytical Support Levels

The appropriate analytical support levels for the RD/RA project are summarized in Table 2-2. For field analyses of indicator parameters such as turbidity, pH and conductivity of ground-water samples, Analytical Level I is appropriate.

Most of the compliance sample analysis will be Level III because the intended data use is "monitoring during implementation" as indicated on Table 2-1. The onsite analysis of verification samples for Aroclor 1260 and TPH will be Level III. The offsite laboratory(s) analysis of TPH or VOCs in ground water and analysis of soil-gas and air samples will also be Level III.

Contract Laboratory Program RAS analyses of confirmation samples for PCBs in soil by the offsite laboratory(s) are designated Analytical Level IV. A level of QA/QC and documentation equivalent to CLP requirements will be required for these Level IV analyses. A higher analytical support level is appropriate as these samples will be used for confirmation of compliance with cleanup levels. For the analysis of PCBs in ground water using the modified extraction methodology to achieve lower detection

limits, Analytical Level V is appropriate, however, the rigorous QA/QC and documentation requirements for Level IV will also be followed for this analysis.

2.2.3 Precision, Accuracy, Representativeness, Completeness and Comparability Criteria

Specific project data quality objectives in terms of PARCC are presented in Table 2-3 and discussed below. Procedures for assessing accuracy, precision and completeness are presented in Section 9.

Acceptable limits for precision and accuracy for CLP RAS analyses have been determined from the *Statement of Work for Organics Analysis* (U.S. EPA, 1990b). Where that document does not provide accuracy and precision goals, the guidance presented in the individual methods or, as appropriate, the guidance provided in *Laboratory Data Validation Functional Guidelines for Organics Analysis* (U.S. EPA, 1988) are used.

The precision and accuracy of the chemical data collected will be calculated as quality control data are received and will be used as an ongoing measurement of performance. Thus, onsite laboratory QC data will be reviewed on a daily basis, and offsite laboratory(s) QC data will be reviewed as soon as the data are available. Should the DQOs not be met, corrective action will be implemented. Note that the precision of data reported at or near detection limits may in many cases be low (i.e., RPD in excess of Table 2-3 goals), even though the data may indicate compliance with cleanup levels. As an example, duplicate values of 0.011 µg/L and 0.019 µg/L result in an apparently "unacceptable" RPD of 53 percent, although both are significantly below the cleanup level of 0.1 µg/L.

The comparability of data will be enhanced by reporting each data type in consistent units. Analytical methods employed will be similar to methods used on the site previously and will yield as low or lower detection limits. Comparability and representativeness are also ensured by the consistent use of field and laboratory procedures established in this Compliance Monitoring Plan.

2.2.4 Level of Confidence

As discussed in Section 2.1.4, the upper confidence limit is defined as $100 \times (1-\alpha)$. The statistical parameters to be used to calculate the upper confidence limit are: α , the false positive rate or Type I error and the confidence limit. The value for α and the confidence limit are specified in the *Statistical Guidance for Ecology Site Managers* (WDOE, 1992), as $\alpha = 0.05$ and 95 percent, respectively ($100 \times (1-\alpha) = 95$ percent). Therefore, these values will be used to calculate the upper confidence limit for the compliance monitoring samples.

Section 3

SAMPLING AND ANALYTICAL METHODS

This section summarizes sampling and analytical methods.

3.1 Sampling Methods

Sampling procedures are discussed in detail in each of the medium-specific Sampling and Analysis Plans. The specific sampling methods developed were adapted from the standard operating procedures listed in Table 3-1.

3.2 Analytical Methods

The analytical methods selected and the rationale for their selection are discussed in detail in each of the medium-specific Sampling and Analysis Plans. For convenience, the analytical methods to be used are also summarized in Table 3-2 of this Quality Assurance Project Plan. The analytical methods were selected based upon the DQOs in Section 2, including the cleanup levels, the analyte(s) of interest, and the detection limit capabilities of the method(s). Method selection was also based upon methods used in past activities at the site to ensure comparability of results.

Specific laboratories to perform the analyses have not yet been identified. The laboratories selected shall be participants in the CLP, or otherwise appropriately qualified. Analytical turn-around time shall be standard for the method (typically 30 days) for air, soil-gas, ground-water, and some soil samples. For some soil samples, accelerated turn-around (typically 48 hours) may be requested.

Section 4

SAMPLE CUSTODY PROCEDURES

Sample custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure that the integrity of the samples is maintained. All samples will be collected in accordance with U.S. EPA chain-of-custody guidelines as prescribed in *NEIC Policies and Procedures (U.S. EPA, 1984)*.

A sample label will be affixed to each individual sample collected. The following information will be recorded on the label of each sample designated for offsite analysis:

- Project name and location;
- Project number;
- Sample date;
- Sampler's initials;
- Sample identification number;
- Sample type;
- Analysis requested; and
- Preservatives added (if applicable).

A multi-ply version of the chain-of-custody form provided in Appendix A will be used to document sample custody. Field sampling personnel will log individual samples onto these forms when they are collected. Entries will include sample identification numbers, matrix, time of collection, and any preservative added. The forms will accompany the samples from the field to the offsite laboratory(s). Whenever a transfer of custody takes place, both parties will sign and date the accompanying chain-of-custody form, and the individual relinquishing the samples will retain a copy of each form. The offsite laboratory(s) will attach copies of the completed chain-of-custody forms to the analytical reports prepared for the samples.

Analytical instructions will be submitted to the laboratory via the laboratory specification, and the analyses requested for each sample will be indicated on the accompanying chain-of-custody form.

A designated sample custodian will take custody of all samples upon their arrival at the laboratory, inspect all sample labels, and examine custody forms to ensure that the information on each corresponds. The custodian will also inspect all samples for signs of damage or tampering. Any discrepancies in information or signs of damage or tampering will be documented by the custodian and reported immediately via telephone and letter. The custodian will then assign a unique laboratory number to each sample, note sample receipt in the laboratory project logbook, and distribute the samples to the appropriate analysts or secured storage areas. All sample transfers in the laboratory will be recorded. Laboratory personnel will be responsible for the care and custody of samples from the time of their receipt at the laboratory through their exhaustion or disposal. The laboratory will retain all written records of laboratory handling and analysis as part of a "permanent" laboratory file. This file shall be retained by the laboratory for a period of at least ten years after reporting of the results.

Section 5

DECONTAMINATION PROCEDURES

The following sections describe the appropriate procedures for equipment decontamination, management of residuals, and wipe sampling to confirm cleanliness after decontamination.

5.1 Decontamination of Equipment

All equipment that comes into contact with potentially chemical containing soil or water will be cleaned. Decontamination will generally consist of steam-cleaning equipment after each use. Any equipment that will come into contact with samples will also be cleaned before use. Equipment will be cleaned on pallets or plastic sheeting, and clean equipment will be stored in clean areas and covered, if it is to be stored more than a few hours.

Small sampling items such as trowels, samplers and brass liners will be steam cleaned or washed with a non-phosphate detergent scrub, followed by fresh water and deionized water rinses. Drilling, sampling, and well installation and development equipment will be cleaned according to the following specific procedures:

- Drill rods, bits, temporary casing, and any other equipment placed in the hole during drilling will be steam-cleaned prior to use and between borings. Visible soil and grease will be removed with a stiff brush;
- Soil samplers will be cleaned prior to each use. Brass tubes for the split-spoon sampler will be new and will be cleaned prior to each use with detergent and hot water to remove any residual cutting oils. The liners will then be rinsed with fresh water, followed by deionized water; and
- Casing, screen, and caps used in monitoring well installation will be steam-cleaned prior to installation. Visible foreign matter will be removed with a stiff brush.

Steel tapes, water level indicators, thermometers, and water quality meters will be rinsed in deionized water or cleaned in a detergent solution and rinsed once in fresh water after each use.

Cleaning of ground-water, air and soil-gas sampling equipment will not be necessary because only dedicated or disposable equipment and supplies will be used.

Personnel decontamination and entry/exit controls are discussed in Section 9 of the Health and Safety Plan.

5.2 Management of Decontamination Fluids and Residual Materials

Management of decontamination fluids and residual materials is addressed in Section 3 of the Investigative and Project Waste Management Plan. During the implementation of compliance monitoring activities, residual materials consisting of drill cuttings, purge water, well development water, and decontamination fluids will be generated.

5.3 Wipe Sampling

After decontamination, wipe samples will be collected from each piece of equipment used for excavation, volume reduction, in-situ vitrification, and grouting to verify cleanliness. Wipe samples will be collected using a laboratory-prepared wipe consisting of cheesecloth saturated with hexane and sealed in a pre-cleaned glass jar. Samples will be collected by removing the wipe from the jar with stainless steel forceps, then swabbing the area enclosed within a 100 square centimeter brass template. The wipe will be passed across the sampling surface once in each direction (up-and-down and back-and-forth). The wipe will then be replaced in the glass jar. Wipe samples will be designated with the prefix WS, followed by sequential numbers indicating the order of sample collection. The forceps and the template will be cleaned with hexane before each use. Wipe samples will be analyzed by the onsite laboratory for Aroclor 1260 and TPH.

Section 6

CALIBRATION PROCEDURES

This section presents the requirements for calibration of field and laboratory instrumentation. The calibration procedures reference standard operating procedures, when available, and specify calibration frequency and standards.

All calibrations for field and laboratory equipment will be recorded in the appropriate logbooks, which will be archived in the Project files.

6.1 Field Instruments

Field instruments and calibration procedures are listed below:

Water-Levels

Electrical probe:

Check against steel tape prior to first use and at least weekly during the field program.

Depth and Distance

Mylar tape:

Check against new steel tape prior to first use and at least monthly during the field program.

pH

Digital pH meter:

Check calibration daily in the field. Use laboratory-supplied buffer solutions (pH 4, 7, and 10) renewed daily in the field. Temperature corrections are applied during measurement.

Turbidity

Colorimetric turbidity meter:

Calibrate daily according to instrument manufacturer's instructions, using solutions of known turbidity within the range of expected sample turbidities.

Electrical Conductivity

Electrical conductivity meter: Calibrate before and after each field use. Temperature correction is applied automatically by instrument during measurement. Calibrate daily against potassium chloride standard - 1413 micro-mhos/cm.

Temperature

Mercury thermometer: Factory calibrated against National Institute of Standards and Technology standards and checked at least annually.

Temperature meter: Calibrate weekly against mercury thermometer.

Thermocouple: Calibrate according to manufacturer's instructions.

Air Flow

Air flow gauge: Calibrate daily according to manufacturer's instructions, and the National Institute of Occupational Safety and Health guidelines.

Soil-Gas Pressure

Solid-state pressure gauge: Calibrate according to manufacturer's instructions.

Barometric Pressure

Certified mercury barometer: Calibrate according to manufacturer's instructions.

Calibration procedures and precision requirements for field measurements are summarized in Table 6-1.

6.2 Laboratory Instruments

The laboratory instruments used during the analysis of samples will be calibrated according to and at the frequency indicated for the specific analytical methods used and instrument manufacturer's recommendations. The analytical methods are discussed in the individual Sampling and Analysis Plans and are summarized in Table 3-2. Procedures specified by the manufacturer of each instrument will be used. The laboratory subcontractors will include specific calibration requirements in their QA/QC Plans. More detailed information concerning instrument calibration procedures may be found in the standard operating procedures on file in the laboratory(s).

Section 7

DATA REDUCTION, VALIDATION, DOCUMENTATION AND REPORTING

This section includes a summary of methods for data reduction, validation, documentation and reporting. Data reduction includes the calculations and transformations of raw data to useful forms for the decision making process. Data validation is the systematic process of evaluating the quality of the laboratory's analytical results. Preliminary data evaluation will be used to provide an immediate quality check of data upon receipt. The use of reporting procedures ensures that all pertinent information from the analysis is accurately presented in a logical and precise manner.

Data collected during the cleanup action activities will be appropriately checked and validated, documented and included in the final report. Audits and statistical assessments of laboratory data will also be conducted as described in Sections 9 and 10.

7.1 Data Reduction

Where test data have been reduced, the method of reduction will be checked by a qualified individual other than the originator and described in the text of the appropriate reports. Reduction of field data will consist of calculation of air and soil-gas sample volumes, conversion of air sample units, and transformation of sample results to the logarithmic form.

Laboratory QA/QC procedures for data reduction shall be described in the subcontractor's laboratory QA/AC Plan. Calculations performed by the laboratory for reporting chemical concentrations will also be performed according to the procedures specified in the referenced method of analysis. Data will be made available in their reduced and raw forms so that calculations can be checked.

7.2 Preliminary Data Evaluation

All analytical data will undergo preliminary data evaluation. Preliminary data evaluation will involve the routine review of field data and laboratory data packages for completeness, compliance with analytical protocols and contract requirements, and correctness. Preliminary data evaluation will also involve an assessment of QC performance and the determination of whether the data appear to be reasonable and consistent based on prior knowledge about the site.

Preliminary evaluation of data obtained from field measurements (Analytical Level I) will be performed by checking procedures utilized in the field, documenting calibration data, and comparing the data to previous measurements when they exist.

Preliminary evaluation of onsite laboratory analytical data (Analytical Level III) will consist of reviewing the packages for completeness and correctness and checking and comparing the quality control results with the DQOs for precision and accuracy discussed in Section 2. The data will also be evaluated to assure that the appropriate number of QC samples are being analyzed, and the results of blanks will be checked for the presence of contamination.

Preliminary evaluation of offsite analytical laboratory data packages will consist of reviewing the packages for completeness and correctness, checking whether appropriate QC samples were analyzed, checking the precision and accuracy and comparing them to the DQOs, and reviewing the results of blanks for contamination. The original and a copy of the data package will be logged into the document control system and a schedule will be prepared for the validation, if appropriate.

7.3 Data Validation

Data validation is a systematic process for assessing the acceptability or validity of data with respect to project goals and requirements for data usability. Ten percent of the confirmation soil samples analyzed by the offsite laboratory will be validated.

Ten percent of the ground-water analytical data packages will be validated. If there are data which cannot be validated, the reason will be documented.

Data shall be validated in accordance with the *Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses* (U.S. EPA, 1988). Data validation will include calculation of the precision, accuracy, and completeness of the data as described in Section 9. The results of these calculations will be compared with the QA objectives listed in Section 2.

Following data validation, qualification flags will be added to the raw analytical data reports and the diskette deliverable. A Validation Summary Report will be prepared for the validated analytical data packages. The report will contain the Laboratory Case Narrative, raw analytical data annotated with qualification flags, and copies of the completed chain-of-custody records. The diskette deliverable, updated to include qualification flags, will be attached.

Deviations from the laboratory subcontract or problems with QC traceability will be documented and reported immediately to the laboratory for resolution. Should poor performance be indicated by the precision or accuracy evaluations, holding times, inadequate QA/QC analyses, or detected concentrations in blank samples, appropriate corrective actions will be initiated.

7.4 Field Documentation Procedures

This section describes procedures for documenting the collection of samples and field measurements and preparation of specialized documentation for various field activities.

7.4.1 Sample Documentation

All information pertinent to field sampling will be recorded in indelible ink in a permanently bound sample logbook. The field sampling personnel will be

responsible for recording all pertinent sampling information including, but not limited to:

- Sample identification numbers;
- Sample collection dates and approximate times;
- Sample matrix;
- Sample depth;
- Sample location;
- Sample characteristics (appearance, odor);
- Sample field measurements (if applicable);
- Sample preservatives (if applicable);
- Type of sampling equipment used;
- Type and number of sample containers;
- Chain-of-custody record number;
- Analysis requested; and
- Sampler's name.

Surveyed sample elevations and coordinates will be added to the sample logbook as these data become available. A separate daily activity logbook will be maintained for recording information such as: field instrumentation readings; calculations; calibration records; photograph references; meeting information; and detailed times and dates of important telephone calls, correspondence, and deliveries. Sample locations will be plotted to scale on a master sample location map at the time of collection.

Entries made in the logbooks will be dated and signed by the individual who made the entry unless entry is by the individual to whom the logbook was originally assigned.

7.4.2 Onsite Laboratory Documentation

Measurements and operations by the onsite laboratory will be recorded in an onsite laboratory logbook with pertinent information necessary to explain and reconstruct field analysis operations. The following information will be recorded in the logbook for each sample analyzed:

- Sample ID;
- Sample matrix;
- Date sampled;
- Date analyzed;
- Sample result; and
- QC results.

Each logbook entry will be made in indelible ink and signed and dated by the analyst.

7.4.3 Geologic Boring Logs

Geologic boring logs will be prepared during drilling of each borehole using the form in Appendix A. Soil samples will be classified and described according to American Society for Testing of Materials Method 2488. The boring log shall include documentation of drilling and sampling equipment; borehole identification number, location, and depth; horizontal position and ground-surface elevation; sample type, depth, and recovery; depth and nature of contacts; depth to ground water; backfilling method; and other pertinent details. Depths will be recorded in feet, to the nearest 0.1 foot.

7.4.4 Well Construction Records

Construction details of ground-water monitoring wells will be recorded on the form in Appendix A. These details will include well identification number; well location; well diameter and total depth; type and depth of casing, screen, filter pack, and annular backfill materials; ground surface and reference point elevations; horizontal coordinates; and surface completion features. Static water levels obtained after well development will also be documented. Depths will be recorded in feet, to the nearest 0.1 foot.

7.4.5 Well Development Records

Well development details will be recorded on the form in Appendix A. These details will include well identification number; start and end date and time; development method and equipment; volume of water removed; turbidity, pH, electrical conductivity and temperature measurements; and well depth and water-level measurements at start and completion of development. Turbidity will be recorded to the nearest 0.1 unit in nephelometric turbidity units (NTUs), pH will be recorded to the nearest 0.1 unit in standard pH units, electrical conductivity will be recorded in micro-mhos/cm to the nearest micro-mhos/cm, and temperature will be recorded in degrees Celsius to the nearest 0.5 degree.

7.4.6 Well Sampling Records

Well sampling details will be recorded on the form in Appendix A. These details will include well identification numbers; water level before purging; sampling and purging method and equipment; start and finish date and time; volume of water purged; turbidity, pH, electrical conductivity and temperature of each purge water sample; date and time of sample collection; number and type of sample containers; and method of preservation. Field measurements shall be recorded in the units listed in Section 7.4.5.

7.4.7 Water-Level Records

Water-level measurements will be recorded on the form in Appendix A. Details to be recorded include the date and time of measurement, well identification number, reference point and depth to ground water. Water-level measurements will be recorded in feet, to the nearest 0.01 feet.

7.4.8 Soil-Gas Sampling Records

Soil-gas pressure measurements will be recorded in a dedicated field logbook as each measurement is obtained by querying the automated data logger. Soil-gas and ambient pressure will be recorded in psig to the nearest 0.01 psig and soil-gas temperature will be recorded in degrees Celsius to the nearest 0.1 degree.

7.4.9 Air Sampling Records

All air sampling activities will be recorded daily in a dedicated logbook and recorded on an Industrial Hygiene Summary Form as shown in Appendix A. Air flow rates will be recorded in liters per minute to the nearest 0.1 L and flow times will be recorded in minutes to the nearest minute.

7.5 Data Reporting

This section describes reporting requirements for data generated during the cleanup activities.

Information collected during the field activities (including the sampling logbook, daily activity logbook, geologic boring logs, well construction details, well sampling records, water-level measurements, and chain-of-custody documents) will be assembled, organized, and maintained in a designated project data center. The designation of a data center will permit the immediate documentation of modifications to the planned field activities and will provide a consistent flow of

information from the field into a format suitable for office analysis. Pertinent information obtained from the daily activity log will be entered onto a computer database and summarized in a monthly status report of field activities.

7.5.1 Onsite Laboratory Reporting

Analytical results generated by the onsite laboratory shall be provided as soon as they become available. At the end of each day, a written report of the day's results (including QC sample results) will be completed. Data generated by the onsite laboratory will be listed in tables which will include sample identification number, laboratory identification number, date received, date extracted or prepared, date analyzed, and matrix description. In addition, the result, units, and reporting limit and actual obtained detection limits will be included in the table for each day's analyses.

Information regarding dilution/concentration factors in the extraction of samples shall be included in the laboratory's daily report. Any problems affecting the analytical results must be reported immediately after they occur. Each month, the onsite laboratory subcontractor shall produce a formal written report for review. This formal report shall include a summary of data generated, a copy of each day's written report, and a log of problems encountered during the project.

7.5.2 Offsite Laboratory(s) Reporting

All data generated by the offsite laboratory(s) will be listed in tables which will include sample identification number, laboratory identification number, date received, date extracted or prepared, date analyzed, matrix description, name of the responsible reporting party, and the name of the approval authority at the laboratory. In addition, the result, units, and reporting limit and actual obtained detection limits will be included in the table for each analysis. The laboratory will qualify the results in the tables as necessary using the data qualifiers described in *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analysis*

(U.S. EPA, 1988). Detailed descriptions of the qualifiers will be included as footnotes to the tables. The most commonly used qualifiers are listed below:

J — Estimated, qualitatively correct, but quantitatively suspect;

R — Rejected, data not suitable for any purpose; and

U — Not detected at a specific detection limit.

The offsite laboratories will provide CLP documentation for (Level IV) confirmation soil and (Level V) ground-water samples. The CLP documentation will consist of detailed data packages as specified in the *Statement of Work for Organics Analysis* (U.S. EPA, 1990b).

Air sampling results will be reported to exposed employees via the Employee Exposure Monitoring Results Notification Form in Appendix A.

7.5.3 Tabulating and Compiling Analytical Data

Analytical data will be tabulated, encoded and entered into a computer database as described in the Data Management Plan. Entry of data to the computer database will be checked by cross-reading hard copy data files with the data in its original form.

7.5.4 Reporting to WDOE

Information contained in the electronic database will be submitted to WDOE on two diskette copies, along with a backup hard copy, with each monthly progress report. Other relevant data which will be provided to WDOE in the monthly progress reports will include:

- Geologic boring logs;
- Well construction records;
- Well development records;

- Well sampling records;
- Soil-gas sampling records; and
- Air sampling records.

7.5.5 Data Archiving

Laboratory reports will be sent directly to the data center during and after the cleanup action. Following completion of the project activities, all materials will be transferred from the data center, including sample logbooks, daily activity logbooks, specialized field data forms, chain-of-custody forms, survey data, as-built drawings, computer files, and other pertinent data. The field information will be organized and stored in a manner that will enable the tracking of documents during the course of the data analysis and interpretation. Other documents that will be included are calculations, facility drawings, and maps that are created following the cleanup action. These documents will be retained for a period of ten years.

Original laboratory reports will be stored along with the project files. After acceptance of the Cleanup Action Report by WDOE, the laboratory reports will be microfilmed and retained in that form for a period of ten years.

Section 8

QUALITY CONTROL CHECKS

This section describes the field and laboratory quality control checks that will be employed to document the absence of cross-contamination, to verify the consistency of field techniques, and to check adherence to the laboratory analytical procedures.

8.1 Description of Quality Control Checks

In general, a higher level of QC corresponds to a higher analytical support level. A higher QC level requires more detailed data validation. Analytical support levels for field analyses (Levels I and II), in general, have lower QC requirements than laboratory analyses (Levels III, IV, and V). It should be noted, however, that analytical support Level V may, in some cases, be an exception. This level may be specified only because the analyses involve method modification or development, but rigorous Level IV QC requirements are still followed.

For Level I and II analyses, no data quality criteria will be specified other than that the calibration of the instrumentation shall be in accordance with and at the frequency specified in the manufacturer's instructions. Field and laboratory quality control checks for Level III, IV and V analyses are outlined in Section 8.2 and 8.3.

Quality control checks include continuing calibration checks and analysis of QC samples. Quality control samples are used to:

- Assess data quality in terms of precision and accuracy; and
- Verify that sampling procedures such as chain-of-custody, decontamination, packaging, and shipping are not introducing variables into the sampling process which could render the validity of samples questionable.

Such QC samples are regularly prepared in the field and laboratory so that all phases of the sampling process are monitored. The types of QC samples to be collected are discussed below.

8.1.1 Continuing Calibration Checks

Routine continuing calibration checks (see Section 6) will be used to verify the validity of the data obtained in the field.

8.1.2 Duplicates

Duplicate samples will be used as a relative measure of the precision of sample collection and analysis processes. Duplicates will be prepared following standard sampling and preparation techniques, and will be matrix specific. Field duplicates are generally submitted "blind". A blind duplicate is submitted as a routine sample with no indication that is a duplicate.

Laboratory duplicates are also used to assess precision of the analysis. Laboratory duplicates usually take the form of matrix spike duplicates. The procedure for assessing precision from duplicates is to calculate the relative percent difference (RPD), percent difference, and the standard deviation, as described in Section 10.

8.1.3 Blanks

Blanks will be used to assess whether contaminants are being introduced into the samples at any given point. Two kinds of blanks will be used; trip blanks, and laboratory blanks. Trip blanks are prepared by the laboratory for volatile organic sampling using organic-free deionized water and are included in the shipment of the containers when they are shipped to the site. Trip blanks are not opened in the field and are shipped back to the laboratory with the collected samples. The purpose of trip blanks is to detect cross-contamination by volatile compounds caused by handling of the samples. Trip blanks are only used, therefore, when samples are to

be analyzed for volatile compounds. Laboratory blanks (or method blanks) are prepared in the laboratory and are identical to trip blanks, except they do not accompany the sample shipments, but are analyzed directly in the laboratory.

8.1.4 Rinsate Samples

Rinsate samples are prepared by collecting samples of rinsate from clean equipment to evaluate the effectiveness of decontamination procedures in preventing cross-contamination of samples.

8.1.5 Spikes

Spikes are intended to evaluate data accuracy. Spikes are prepared by the laboratory by spiking samples with representative constituents for the analysis to be performed. The results are reported with the laboratory data and as percent recovery.

8.1.6 Replicates

Replicates consist of duplicate analyses of the same sample or extract volume.

8.2 Field Quality Control Checks

Field QC checks will consist of submission of blank, duplicate and rinsate samples to the laboratory(s). The nature and frequency of these samples are described below.

8.2.1 Duplicates

During soil, soil-gas, air, and ground-water sampling, one field duplicate will be collected and submitted to the laboratory for every 20 samples.

8.2.2 Blanks

One trip blank will be submitted to the laboratory for analysis along with every 20 ground-water submitted for volatile organic compound analysis, or one per shipment, whichever is greater. Trip blanks will consist of reagent-grade organic-free deionized water supplied by the laboratory and will be analyzed for volatile organics.

One ambient air blank will be submitted to the laboratory for analysis along with every batch of air or soil-gas samples to be analyzed for volatile constituents.

8.2.3 Rinsate Samples

Rinsate samples will only be prepared for soil sampling, which unlike sampling of the other matrices, requires equipment decontamination. During soil sampling, one rinsate sample will be collected and submitted to the laboratory at a minimum frequency of one per sampling apparatus per sampling event (a sampling "event" would be a concurrent effort to collect similar samples such as excavation sampling or treated soil sampling, etc.) Rinsate samples will consist of reagent-grade purified water poured over or through sampling equipment after decontamination. Decontamination rinsate samples will be analyzed using each type of analytical method performed on the soil samples.

8.3 Laboratory Quality Control Checks

This section describes the QC checks for the onsite and offsite laboratories.

8.3.1 Onsite Laboratory Quality Control Checks

Laboratory QC checks for the onsite laboratory will include the following:

- Calibration of the analytical instruments as described in and at the frequency prescribed in the instrument manufacturer's instructions;
- Analysis of standards for each instrument three times daily (morning, mid-day, and afternoon);
- Analysis of one matrix spike each day;
- Analysis of one matrix spike duplicate each day;
- Analysis of one replicate (re-analysis of sample extract) each day;
- Analysis of a limited number of sample splits following the full extraction method specified in U.S. EPA Method 8080 as a check on the onsite extraction methodology; and
- Inclusion of a limited number of sample splits in the offsite laboratory(s) analytical stream as a control check for onsite analysis.

The onsite laboratory will be required to have QA/QC plan prior to initiation of work.

8.3.2 Offsite Laboratory(s) Quality Control Checks

Laboratory QC checks for chemical analyses performed by the offsite laboratory will include the following:

- Calibration of the instruments as described in and at the frequency prescribed for the analytical methods and in the instrument manufacturers' instructions;
- Analysis of standards for each analytical method at the start of each laboratory shift;
- Analysis of one laboratory blank for every 20 samples analyzed by each analytical method, or one per batch, whichever is greater;
- Analysis of one matrix spike sample for every 20 samples analyzed, or one per batch, whichever is greater; spike samples will be spiked with representative compounds for each analytical method performed; and

- Analysis of one matrix spike duplicate sample for every 20 samples analyzed, or one per batch, whichever is greater.

The offsite laboratory(s) will have a QA/QC plan and will participate in the CLP. All analyses will be performed in accordance with the laboratory's QA/QC plan as well as in accordance with specified analytical methods. The analyses are also to be performed in accordance with the requirements stated in this Quality Assurance Project Plan.

Section 9

SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA QUALITY

Analytical data derived from samples will be evaluated in terms of accuracy, precision, and completeness. A combination of statistical procedures and qualitative evaluations will be used to check the quality of the data. However, data will not be removed from the database based on statistical evaluations. If the quality of any data is questionable, the data will be annotated in the final report.

The assessment procedures in this section are designed for review of spikes, duplicates, and blanks. These procedures are presented in Sections 9.1 through 9.3. In addition, the procedure for evaluating completeness of the data is presented in Section 9.4. The calculations listed below will be performed by the onsite and offsite laboratories and will be checked during data validation. Furthermore, CLP documentation packages will be prepared by the offsite laboratory(s). The laboratory will use these or equivalent methods for evaluating data quality as presented in the *Statement of Work for Organics Analysis (U.S. EPA, 1990b)*.

9.1 Accuracy

The procedure for assessing accuracy from matrix spike samples will be as follows:

- Step 1. Tabulate matrix spike sample data and calculate the percent recovery (PR) as shown below for each sample:

$$\text{Percent Recovery} = \frac{T-X}{A} \times 100\%$$

where:

T = Total concentration found in the spiked sample;

X = Original concentration in sample; and

A = Actual spiked concentration added to the sample.

Step 2. Calculate the mean and standard deviation of the percent recoveries using the sum of the squares method shown below:

$$S = \sqrt{\frac{\sum(\bar{x} - X)^2}{n-1}}$$

where:

S = Standard deviation;

n = Number of PRs used in calculation;

X = Individual calculated PR values; and

\bar{x} = Mean of calculated PRs.

Step 3. Qualitatively evaluate the significance of data that fall outside reasonable recovery limits. If data fall outside reasonable recovery limits, the data from that period of time will be re-evaluated for the compound that did not meet the limits. Poor data will not be removed from the database, but may result in the qualification of interpretations which rely on these data.

9.2 Precision

The procedure for assessing precision using duplicate samples (matrix spike duplicates) will be as follows:

Step 1. Tabulate duplicate data and calculate the relative percent difference and percent ratio as shown below for each duplicate pair:

$$\text{Relative Percent Difference} = \frac{X_1 - X_2}{\bar{X}} \times 100\%$$

$$\text{Percent Ratio} = \frac{X_1}{X_2} \times 100\%$$

where:

X_1 = Concentration of sample 1 of duplicate;

X_2 = Concentration of sample 2 of duplicate; and

\bar{X} = Mean of samples 1 and 2.

Step 2. Calculate the average RPD for all duplicate pairs.

Step 3. Calculate the standard deviation of the RPDs using the formula shown below:

$$S = \sqrt{\frac{\sum(\bar{x} - X)^2}{n-1}}$$

where:

S = Standard deviation;

n = Number of RPDs used in calculation;

X = Individual calculated RPD values; and

\bar{x} = Mean of calculated RPDs.

Step 4. Identify any duplicate pairs that have an RPD greater than 25 percent or a percent ratio less than 15 percent.

Step 5. Qualitatively evaluate the significance of data that fall outside the 25 percent RPD cutoff. Poor precision is expected for any compounds which are within 10 times the method detection limit, so initiation of corrective action within this range is not normally expected. If precision is deemed poor, the laboratory will be notified for appropriate corrective action following the procedures in Section 12.

9.3 Blanks

The evaluation procedure for blanks will be a qualitative review of the data reported by the laboratories. The procedure for assessing blank samples will be as follows:

- Step 1. Tabulate the data from the blank samples.
- Step 2. Identify any blank samples in which chemicals are detected.
- Step 3. If chemicals are not detected in any of the blank samples, their absence will be so stated in the final report.
- Step 4. If chemicals are detected in the blank samples, the laboratory will be asked to review other recent blank sample results to determine whether or not the finding is an isolated incident.
- Step 5. If any chemicals are found in blank samples, the compound(s) and concentration(s) will be reported, and the data for that period of time will be assessed for potential misinterpretation. If there is sampling yet to be completed, corrective action will be initiated following the procedures in Section 12. Data will not be removed from the database based on the detection of chemicals in blank samples. Notations will, however, be made in the appropriate reports.

9.4 Completeness

To evaluate completeness of the analytical data, the data set will be reviewed to verify that all sampling and analysis which were planned in the Compliance Monitoring Plan were performed. Samples not analyzed or reported outside of limits and flagged by the laboratory as not usable will be identified. The following will be used to evaluate completeness:

$$\text{Completeness} = \frac{N_{At}}{N_{Pt}} \times 100\%$$

where:

- N_{At} = The number of actual valid samples or measurements over a given time period, t ; and
 N_{Pt} = The number of possible samples (planned) over a given time period, t .

Section 10

AUDITS

System and performance audits will be conducted of the field and laboratory procedures, as described below. Audits will be performed as early in the field and analytical programs as is reasonably possible to ensure that any developing problems are identified at the earliest possible time.

10.1 System Audits

Once during the initial two weeks of field cleanup action activities, a system audit of drilling, sampling, onsite laboratory analysis, and associated documentation will be conducted. The system audit will focus on adherence to procedures outlined in the Compliance Monitoring Plan. The drilling and sampling audit will include field observation of drilling and sampling and inspection of selected documentation. The sampling and analysis audit will include field observation of sampling procedures, selected documentation (e.g., chain-of-custody forms) and review of QC data for chemical analyses.

An audit of the offsite analytical laboratory will only be conducted if deemed necessary by poor analytical performance, such as accuracy and precision outside of goals, cross-contamination of blanks, failure to meet detection limits or holding times, etc.

Audit reports will be prepared for each audit conducted. Audit findings which require corrective action and follow-up will be documented, tracked, and will have resolution verified complete.

10.2 Performance Audits

The purpose of performance audits is to assess the precision and accuracy of the sampling and analysis procedures. A performance audit will be conducted at least once during the field sampling activities.

Once during the initial week of soil cleanup sampling, split samples will be submitted to an offsite laboratory(s) for PCB analysis to verify onsite analytical results at an early stage of the cleanup action. An agreement of ± 25 percent RPD will be required between offsite and onsite analysis.

Section 11

PREVENTATIVE MAINTENANCE

Equipment used for field measurements will receive routine maintenance checks in order to minimize equipment downtime. Maintenance checks will generally coincide with calibration checks. Any equipment found to be operating improperly will be taken out of use, and a note stating the time and date of this action will be made in the daily activity logbook. The equipment will be repaired, replaced, or re-calibrated, as necessary, and the time and date of its return to service will also be recorded.

Section 12

CORRECTIVE ACTION

The need for corrective action may be identified during the review of data, field sampling, audits, or safety and health surveillance. Corrective action is required when procedures or programs are not followed or when circumstances result in the quality of activities, measurements, samples, or data being questioned. Any project personnel may identify and document the need for corrective action. When items are identified which require corrective action, they should be immediately corrected by the individual noting the problem, if appropriate, or brought to the attention of the appropriate supervisor. Corrective actions taken will be documented in the daily activity logbook.

When a situation is identified which cannot be resolved immediately, or the condition observed may result in data or samples previously collected being questioned, a formal corrective action form will be prepared (Appendix A). Corrective action forms will be forwarded to the Bechtel Project Manager for resolution. A copy of the corrective action form will be forwarded to the Data Coordinator for tracking. Corrective action is then controlled by response to the corrective action forms. Any required corrective action will be verified as complete and effective.

Section 13

QUALITY ASSURANCE REPORTS

The results of system and performance audits, QC samples, data validation, and any required corrective action will be reported in the monthly progress reports to WDOE and summarized in the Cleanup Action Report (as described in the Soil Treatment Plan).

TABLES

TABLE 2-3
PRECISION, ACCURACY AND COMPLETENESS GOALS

PARAMETER	METHOD ^(a)	REFERENCE	PRECISION ^(b) (RPD)	ACCURACY ^(c) (Percent)	COMPLETENESS (Percent)
PCBs					
Soil	CLP RAS, GC/ECD	U.S. EPA, 1990b	35	35-130	95
Water	U.S. EPA 608, GC/ECD (modified low-level extraction)	U.S. EPA, 1986	20	75-125	95
TOTAL PETROLEUM HYDROCARBONS					
Soil	U.S. EPA 418.1, IR	U.S. EPA, 1986	35	75-125	95
Water	U.S. EPA 418.1, IR	U.S. EPA, 1986	20	80-120	95
VOLATILE ORGANICS					
Water	CLP RAS, GC/MS	U.S. EPA, 1990b	13	70-130	90

Notes:

- (a) GC/ECD = Gas chromatograph/electron capture detector; GC/MS - Gas chromatograph/mass spectrometer, IR - Infrared spectrometer.
- (b) Maximum relative percent difference (RPD) at ten or more times the limit of detection.
- (c) Percent recovery.

TABLE 3-1

STANDARD OPERATING PROCEDURES FOR FIELD SAMPLING

<i>Sampling Method</i>	<i>Standard Operating Procedure</i>
<u>Soil</u>	
Grab Sampling	U. S. EPA SOP 2012(a)
Split-Spoon Sampling	ASTM 2488
Dip Sampling	ISV Demonstration Test Plan(b)
<u>Ground-Water</u>	
	U. S. EPA SOP 2007(c)
	Hydrostar™ (proprietary)
	operational guidelines
<u>Soil-Gas</u>	
	U. S. EPA SOP 2149(a)
<u>Air</u>	
PCBs	NIOSH 5503(d)
VOCs	NIOSH 1500(d)
Nuisance Dust, total	NIOSH 0500(d)
Nuisance Dust, respirable	NIOSH 0600(d)

Notes:

- (a) From *Compendium of ERT Soil Sampling and Surface Geophysics Procedures* (U. S. EPA, 1991b).
- (b) From *Geosafe*, 1990.
- (c) From *Compendium of ERT Ground-Water Sampling Procedures* (U. S. EPA, 1991c).
- (d) NIOSH = National Institute of Occupational Safety and Health.
- (e) ASTM = American Society for Testing and Materials.

TABLE 3-2

ANALYTICAL METHODS

<i>Parameter</i>	<i>Method Number</i>	<i>Method</i>	<i>Detection Limits(a)</i>
A. OFFSITE LABORATORY(S)			
I. PCBs			
Soil	CLP RAS(b)	GC/ECD(c)	0.033 mg/kg
Water	CLP SAS(b)	GC/ECD(f)	0.05 µg/L
Air	NIOSH 5503	GC/ECD(c)	0.03 µg/sample
II. Total Petroleum Hydrocarbons			
Soil	U.S. EPA 418.1(e)	IR(g)	10 mg/kg
Water	U.S. EPA 418.1(e)	IR(g)	1 mg/L
III. Volatile Organics			
Water	CLP RAS (b)	GC/MS(h)	10 µg/kg
Air	NIOSH 1500	GC/MS(h)	0.001-0.01 mg/sample
IV. Nuisance Dust			
Air (total)	NIOSH 0500	Gravimetry	0.2 mg/sample
Air (respirable)	NIOSH 0600	Gravimetry	0.2 mg/sample
B. ONSITE LABORATORY			
I. PCBs (Aroclor 1260)			
Soil	U.S. EPA 8080(d,k)	GC/ECD(c)	1 mg/kg
II. TPH			
Soil	U.S. EPA 418.1	IR(g)	10 mg/kg

Notes:

- (a) Specific detection limits for volatile organic compounds and PCB Aroclors are provided in the SAPs.
- (b) Analytical methods obtained from *Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration* (U.S. EPA, 1990b).
- (c) GC/ECD = Gas chromatograph/electron capture detector.
- (d) Analytical methods obtained from *Test Methods for Evaluating Solid Waste, EPA-SW-846, 3rd edition* (U.S. EPA, 1986).
- (e) Analytical methods obtained from *Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020* (U.S. EPA, 1983).
- (f) Modified low level extraction procedure from *SOP for Extraction of BNA's/PEST/PCB/OP-PEST in Water, Version 1.0* (U.S. EPA, 1991a).
- (g) IR = Infrared spectroscopy.
- (h) GC/MS = Gas chromatograph/mass spectrometer.
- (i) GC/FID = Gas chromatograph/flame ionization detector.
- (j) Analytical methods obtained from *A Compendium of Superfund Field Operations, EPA/540/p-87-001b* (U.S. EPA, 1987c).
- (k) Extraction method developed by Thomas M. Spittler at U.S. EPA Region I (U.S. EPA Manchester Laboratory, 1991a).

TABLE 6-1

FIELD INSTRUMENT CALIBRATION

<i>Field Measurement</i>	<i>Instrument</i>	<i>Calibration Procedure</i>	<i>Precision</i>
Water levels	Electrical water probe	Reference to steel tape	0.05 ft
Depth of sample site, length of sample	Mylar tape	Reference to new tape	0.1 ft
Location of sample site, and layout	Mylar tape	Reference to new tape	1.0 ft
Azimuth bearing (grid layout)	Pocket transit	Factory calibration, set magnetic declination at first use	1 degree
Water pH	pH meter	Calibrate daily against 3- point buffer solutions	0.1 pH unit
Turbidity	Colorimetric turbidity meter	Calibrate daily against standard NTU solutions	1 NTU
Electrical conductivity	Conductivity meter	Calibrate daily against KCl reference solution	1%
Water temperature	Thermometer	Factory calibration	0.5°C
	Temperature meter	Calibrate weekly against mercury thermometer	0.5°C
Soil-gas temperature	Thermocouple	Manufacturer's instructions	0.1 °C
Air flow	Air flow gauge	Factory calibration; manufacturer's instructions	10%
Soil-gas pressure	Solid-state pressure gauge	Manufacturer's instructions	0.01 psig
Barometric pressure	Certified mercury barometer	Manufacturer's instructions	0.01 psig

TABLE 3-1

STANDARD OPERATING PROCEDURES FOR FIELD SAMPLING

<i>Sampling Method</i>	<i>Standard Operating Procedure</i>
<u>Soil</u>	
Grab Sampling	U. S. EPA SOP 2012(a)
Split-Spoon Sampling	ASTM 2488
Dip Sampling	ISV Demonstration Test Plan(b)
<u>Ground-Water</u>	
	U. S. EPA SOP 2007(c)
	Hydrostar™ (proprietary)
	operational guidelines
<u>Soil-Gas</u>	
	U. S. EPA SOP 2149(a)
<u>Air</u>	
PCBs	NIOSH 5503(d)
VOCs	NIOSH 1500(d)
Nuisance Dust, total	NIOSH 0500(d)
Nuisance Dust, respirable	NIOSH 0600(d)

Notes:

- (a) From *Compendium of ERT Soil Sampling and Surface Geophysics Procedures* (U. S. EPA, 1991b).
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IV. Nuisance Dust			
Air (total)	NIOSH 0500	Gravimetry	0.2 mg/sample
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Soil	U.S. EPA 8080(d,k)	GC/ECD(c)	1 mg/kg
II. TPH			
Soil	U.S. EPA 418.1	IR(g)	10 mg/kg

Notes:

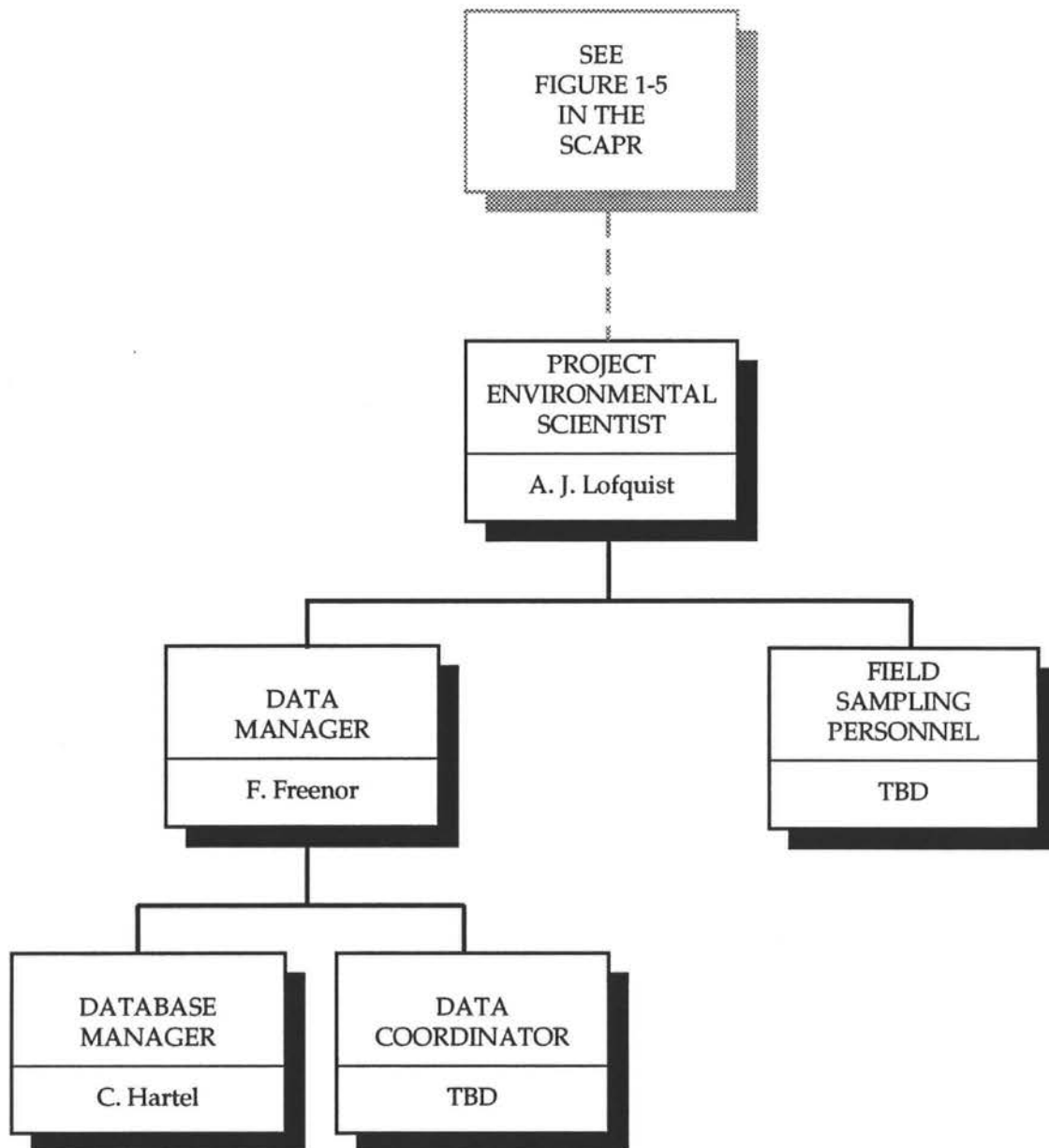
- (a) Specific detection limits for volatile organic compounds and PCB Aroclors are provided in the SAPs.
- (b) Analytical methods obtained from *Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration* (U.S. EPA, 1990b).
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- (e) Analytical methods obtained from *Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020* (U.S. EPA, 1983).
- (f) Modified low level extraction procedure from *SOP for Extraction of BNA's/PEST/PCB/OP-PEST in Water, Version 1.0* (U.S. EPA, 1991a).
- (g) IR = Infrared spectroscopy.
- (h) GC/MS = Gas chromatograph/mass spectrometer.
- (i) GC/FID = Gas chromatograph/flame ionization detector.
- (j) Analytical methods obtained from *A Compendium of Superfund Field Operations, EPA/540/p-87-001b* (U.S. EPA, 1987c).
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Turbidity	Colorimetric turbidity meter	Calibrate daily against standard NTU solutions	1 NTU
Electrical conductivity	Conductivity meter	Calibrate daily against KCl reference solution	1%
Water temperature	Thermometer	Factory calibration	0.5°C
	Temperature meter	Calibrate weekly against mercury thermometer	0.5°C
Soil-gas temperature	Thermocouple	Manufacturer's instructions	0.1 °C
Air flow	Air flow gauge	Factory calibration; manufacturer's instructions	10%
Soil-gas pressure	Solid-state pressure gauge	Manufacturer's instructions	0.01 psig
Barometric pressure	Certified mercury barometer	Manufacturer's instructions	0.01 psig

FIGURES



Bechtel SAN FRANCISCO			
GENERAL ELECTRIC/SPOKANE			
ORGANIZATION OF DATA MANAGEMENT TEAM			
	Job Number	Drawing No.	Rev.
	19099	FIGURE 1-1	A

APPENDIX A

JOB NUMBER 19099

COC #

DATE: _____

PROJECT CONTACT:

SAMPLER'S NAME: _____

PHONE NUMBER: _____

SAMPLER'S SIGNATURE: _____

FAX NUMBER: _____

ANALYTICAL LABORATORY:

REMARKS:

G = Clear Glass Jar
AG = Amber Glass Jar
V = VOA Vial
L = Liner
P = Polyethylene

ANALYSIS

PCBs (EPA 608-Modified Extraction)

CLP RAS VOLATILES

TPH (EPA 418.1)

CLP RAS PCBs

LAB QC (MS/MSD)

EXPEDITED TURNAROUND TIME:

ARCHIVE

**SAMPLE ID
NUMBER**

DATE/
TIME

STATION DESCRIPTION

SAMPLE MATRIX

**TYPE/NO. OF
CONTAINERS**

RELINQUISHED BY:

RECEIVED BY:

DATE: _____

TIME:

SEND ANALYTICAL RESULTS AND INVOICE TO:



GEOLOGIC LOG

PROJECT and JOB NUMBER
GE - SPOKANE

19099

SHEET NO.
1 OF 2

HOLE NO.
1

DRILLER

SITE and LOCATION

OVERBURDEN

BEGUN

DRILL MAKE AND MODEL

COORDINATES

GROUND ELEVATION

ROCK (FT)

COMPLETED

HOLE SIZE SAMPLE HAMMER WEIGHT/FALL

LOGGED BY:

TOTAL DEPTH
75.0

UPDATE
8-19-93

Sampler
Advance

Blow Counts or
Recovery (ft)

Sampler Type

Elevation
in Feet

Depth in Feet

Graphics

Sample

Description and Classification

(Template: GEN)

Remarks:

5

10

15

20

25

30

SITE and LOCATION

HOLE NO.

1



MONITORING WELL

PROJECT

GE - SPOKANE

WELL NO.

JOB NO.

19099

SITE

FORMER SERVICE SHOP

COORDINATES

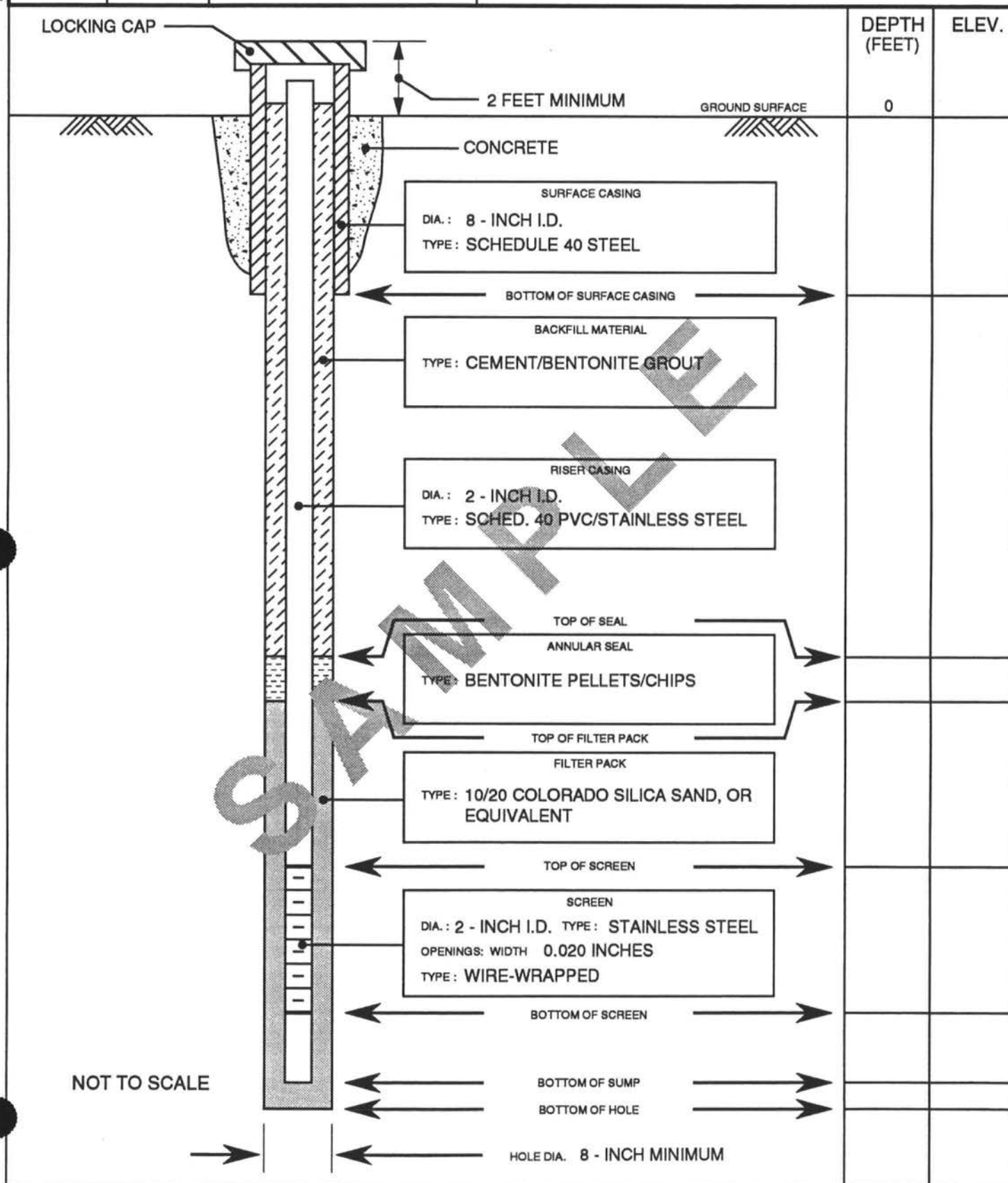
BEGUN

COMPLETED

PREPARED BY

REFERENCE POINT FOR MEASUREMENTS

TOP OF RISER CASING





DATE _____

INSPECTOR

[illegible]

WELL DEVELOPMENT

JOB NO.

SITE

PREPARED BY	
-------------	--

METHOD

PUMP

BAILER

GAS

OTHER

DEVELOPMENT CRITERIA	
1	1.1
2	2.1
3	3.1
4	4.1
5	5.1
6	6.1
7	7.1
8	8.1
9	9.1
10	10.1
11	11.1
12	12.1
13	13.1
14	14.1
15	15.1
16	16.1
17	17.1
18	18.1
19	19.1
20	20.1
21	21.1
22	22.1
23	23.1
24	24.1
25	25.1
26	26.1
27	27.1
28	28.1
29	29.1
30	30.1
31	31.1
32	32.1
33	33.1
34	34.1
35	35.1
36	36.1
37	37.1
38	38.1
39	39.1
40	40.1
41	41.1
42	42.1
43	43.1
44	44.1
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84	84.1
85	85.1
86	86.1
87	87.1
88	88.1
89	89.1
90	90.1
91	91.1
92	92.1
93	93.1
94	94.1
95	95.1
96	96.1
97	97.1
98	98.1
99	99.1
100	100.1

REMARKS

HOLE DIAMETER d_h = _____

WELL CASING

INSIDE DIAM d_w ID = _____

OUTSIDE DIAM d_w OD = _____

DEPTH TO:

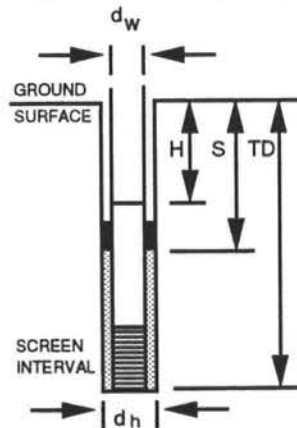
WATER LEVEL H = _____

BASE OF SEAL S = _____

BASE OF WELL TD = _____

EST. FILTER 0.25

PACK POROSITY P = 0.25



WELL VOLUME CALCULATION

CASING VOLUME =

$$V_c = \pi \left(\frac{d_w D}{2} \right)^2 (TD - H) = 3.14 \left(\frac{\quad}{2} \right)^2 (\quad - \quad) = \quad \text{ft}^3$$

FILTER PACK PORE VOLUME =

$$V_f = \pi \left[\left(\frac{d_h}{2} \right)^2 - \left(\frac{d_w OD}{2} \right)^2 \right] (TD - (S \text{ or } H)) (P)$$

$$= 3.14 \left[\left(\frac{\quad}{2} \right)^2 - \left(\frac{\quad}{2} \right)^2 \right] (\quad - \quad) (\quad) = \quad \text{ft}^3$$

(If $S > H$ use S . If $S < H$, use H)

TOTAL WELL VOLUME =

$$V_T = V_G + V_f = \quad + \quad = \quad \text{ft}^3 \times 7.48 = \quad \text{GAL}$$

[illegible]

WELL SAMPLING FORM

PROJECT

WELL NO.

JOB NO.

SITE

PREPARED BY	
-------------	--

METHOD

PUMP

BAILER

GAS

OTHER

DEVELOPMENT CRITERIA

REMARKS

HOLE DIAMETER

 d_h Springer

WELL CASING

dw

10

INSIDE DIAM

dw

—

DEPTH TO:

H

WATER LEVEL

S

BASE OF SEAL

TD

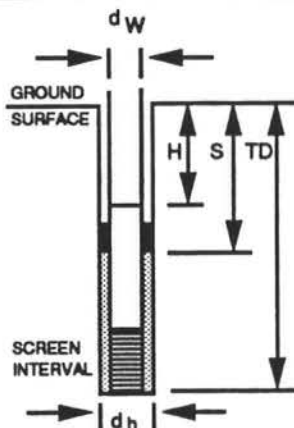
■

EST. FILTER

P

—

PACK POROSITY



WELL VOLUME CALCULATION

CASING VOLUME =

$$V_c = \pi \left(\frac{d_w D}{2} \right)^2 (TD - H) = 3.14 \left(\frac{\quad}{2} \right)^2 (\quad - \quad) = \quad \text{ft}^3$$

FILTER PACK PORE VOLUME =

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$$= 3.14 \left[\left(\frac{\quad}{2} \right)^2 - \left(\frac{\quad}{2} \right)^2 \right] (\quad - \quad) (\quad) = \quad \text{ft}^3$$

(If $S > H$ use S . If $S < H$, use H)

TOTAL WELL VOLUME =

$$V_T = V_G + V_f = \quad + \quad = \quad \text{ft}^3 \times 7.48 = \quad \text{GAL}$$

[illegible]

SAMPLE ALTERATION CHECKLIST

Project Name and Number: GE-Spokane RD/RA 19099-006

Material to be sampled: _____

Measurement Parameter: _____

Deviation from Project Plan
Activities: _____

Initiator's Name: _____

Date: _____

Project Approval: _____

CORRECTIVE ACTION FORM

Project Name and Number: _____

Sample Dates Involved: _____

Measurement Parameter(s): _____

Acceptable Date Range: _____

Problem Area Requiring
Corrective Action: _____

Measures Required to
Correct Problems: _____

Means of Detecting Problems and
Verifying Correction: _____

Initiator's Name: _____ Date: _____

Project Approval: _____ Date: _____

Laboratory Approval: _____ Date: _____

QA Supervisor: _____ Date: _____

Employee Notification
Of Industrial Hygiene Monitoring Results

To be completed by the SHSO.

Employee Name _____ SSAN _____

Division _____ Location _____

Job Name _____ Job Number _____

Job Supervisor _____

Material or Agent Monitored _____

Results _____ mg/M³ [], ppm [], Other _____

OSHA Standard _____ mg/M³ [], ppm [], Other _____

Protective Equipment Used: (Describe specifically)

Health & Safety

Representative: _____

Name Printed

Signature

Date

For Jobs where airborne concentrations or levels were found to be in excess of the OSHA permissible exposure level the following corrective action steps (engineering, administrative, job technique, etc.) are being taken to reduce potential future exposures:

PAGE _____ v. _____

20

ADDITIONAL COM

21

218 DATA AND CALCULATIONS

21c IH/HP REVIEW

DATE _____

REFERENCES

REFERENCES

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GE-SPOKANE REMEDIAL DESIGN/REMEDIAL ACTION PROJECT

DATA MANAGEMENT PLAN

Prepared for

GENERAL ELECTRIC COMPANY

by

BECHTEL ENVIRONMENTAL, INC.

San Francisco, California

December 1993



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- 3-2 Coefficients a_i for the Shapiro-Wilk W Test for Normality
- 3-3 Quantiles of the Shapiro-Wilk W Test for Normality
- 3-4 One-Sided Confidence Limit Values
- 3-5 Values of $H_{1-\alpha} = H_{0.95}$ for Computing a One-Sided Upper 95 Percent Confidence Limit on a Lognormal Mean
- 3-6 Values of λ for Estimating the Mean and Variance of a Normal Distribution Using a Singly Censored Data Set

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- 1-2 Site Ownership and Former Facilities
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- 3 Final Acceptance Calculations for Normally Distributed Soil PCB Data
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- 6 Final Acceptance Calculations for Lognormally Distributed Soil TPH Data
- 7 Compliance Monitoring Calculations for Normally Distributed Ground-Water PCB Data
- 8 Compliance Monitoring Calculations for Lognormally Distributed Ground-Water PCB Data

Section 1

INTRODUCTION

This Data Management Plan was prepared by Bechtel Environmental, Inc. (Bechtel) for General Electric Company (GE) as one of the Project Plans for the GE-Spokane Remedial Design/Remedial Action (RD/RA) Project, as required under the *Consent Decree* (WDOE, 1993b) between GE and the Washington Department of Ecology (WDOE).

The purpose and scope of the Data Management Plan and the project background are discussed in the remainder of Section 1. Section 2 provides a summary of indicator chemicals and cleanup levels for soil and ground water and action levels for air. Section 3 describes the procedures for demonstrating compliance with cleanup levels as well as procedures for comparing data to action levels. Section 4 provides the schedule for formal data reviews, and Section 5 describes the electronic format for data submittal. References are provided in Section 6. Table 1-1 provides a cross-reference indicating where the Consent Decree requirements are addressed in this plan.

1.1 Purpose and Scope

According to the *Consent Decree* (WDOE, 1993b) "A procedure for ground-water, air and soil data analysis and evaluation must be established to demonstrate compliance with site cleanup levels". The purpose of this Data Management Plan is to provide these required procedures. WDOE has established site-specific cleanup levels for soil and ground-water, so the procedures to demonstrate compliance with cleanup levels apply to soil and ground-water data only.

In the Consent Decree, WDOE also specifically requires a list of action levels. Because there are no "site cleanup levels" for air monitoring, it is interpreted that these action levels refer to air monitoring data. Therefore, published regulatory

exposure limits have been selected as action levels for air monitoring and a procedure has been provided for comparing air monitoring data to these levels.

The specific cleanup levels and action levels are presented in Section 2.

1.2 Project Background

GE operated an apparatus service shop at East 4323 Mission Avenue in Spokane, Washington, during the period 1961 to 1980 (see Section 2 of the Summary Cleanup Action Planning Report for more information regarding the service shop). Figure 1-1 shows the project site location and Figure 1-2 shows the site layout, including the former facilities, as existed in 1989. Existing site surface features are shown in Figure 1-3.

In 1985, polychlorinated biphenyls (PCBs) were detected in site soils. GE subsequently performed Phase 1, 2, and 3 investigations of PCBs and other constituents in soil and ground water. More information about these investigations is presented in *Bechtel, 1986a; Bechtel, 1986b; Bechtel, 1987; and Golder, 1988*.

In 1989, the site was placed on the National Priorities List (NPL), by the U. S. Environmental Protection Agency (U.S. EPA). Therefore, the site investigations and cleanup are subject to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the Superfund Amendments and Reauthorization Act (SARA). The site is also subject to the State of Washington Model Toxics Control Act (MTCA). The U.S. EPA designated Washington Department of Ecology (WDOE) as the lead regulatory agency for this site.

The area designated as the NPL site includes the GE property and adjacent properties owned by Washington Water Power and Mr. Marvin E. Riley, doing business as Federal Construction Company. Following the change to NPL status, GE entered into an Agreed Order with WDOE. Under the terms of the Agreed Order, GE subsequently performed a two-phase remedial investigation (Phase 4 for soils and other solid materials and Phase 5 for ground water) and a baseline risk assessment (see *Bechtel, 1991a; Everest, 1992; and Golder, 1992*).

The remedial investigations indicated that PCBs were present in surface soils, in sediments in sumps and other underground structures, and in soils beneath these structures, including the West Dry Well where steam cleaning effluent was discharged during operation of GE's service shop. Concentrations of PCBs were also detected in ground-water samples collected from wells downgradient of the West Dry Well. Petroleum hydrocarbons, metals and volatile organic compounds (VOCs) were also detected in some soil or ground-water samples. The extent of residual chemicals is described in more detail in Section 2 of the Summary Cleanup Action Planning Report.

During the Phase 4 Remedial Investigation, GE conducted some interim actions, including demolition of the site building and excavation of underground structures and associated soils. These activities are described in the reference *Bechtel, 1991a*.

Since about 1986, GE has been exploring the possible use of in situ vitrification (ISV) for treating the soils containing PCBs at the site. The ISV technology, which is a thermal treatment/immobilization process, is described further in Section 4 of the Soil Treatment Plan. In order to use this technology for treatment of PCB-containing soils at the GE-Spokane site, a Toxic Substances Control Act (TSCA) - required demonstration test must be performed so that the vendor of the technology, Geosafe Corporation (Geosafe), may obtain a TSCA permit for "disposal" of PCBs.

It was planned to conduct the ISV Demonstration Test at the GE-Spokane site in 1991. Shallow soils previously identified as PCB-containing were excavated and placed in five test cells along with soils spiked with imported PCBs and other materials removed during the interim actions described above. The preparations for the ISV Demonstration Test are described more completely in the reference *Bechtel, 1991b*. The planned demonstration test was delayed due to a mishap which occurred during an Operational Acceptance Test of the ISV equipment conducted by Geosafe at its Richland, Washington test site.

Under TSCA, a certificate of disposal must be provided within one year from the date when PCBs are "taken out of service" or removed from their original location. The PCB-spiked soils in one of the ISV test cells are subject to this requirement. The TSCA Section of U.S. EPA Region X was notified that, due to the delay in the

planned ISV Demonstration Test, the spiked soils might remain in place for more than one year. U.S. EPA Region X granted an extension of the disposal certification requirement, with the provision that a plan and schedule for properly disposing of the materials "taken out of service" be submitted by October 1, 1993. A temporary cap was placed over the test cells in November 1991 to prevent infiltration of precipitation into the test cells and periodic site maintenance and inspections have been conducted since that time. The current schedule provided by Geosafe indicates the ISV Demonstration Test may be performed in early 1994.

After completion of the remedial investigations, GE conducted a feasibility study to evaluate remedial alternatives for soil and ground water (*Bechtel, 1992*). The feasibility study concluded that in situ vitrification would be the preferred cleanup action for soils, and institutional controls coupled with ground-water monitoring would be the preferred action for ground water. Contingent remedies were also identified in the feasibility study, for implementation in the event that ISV is not successfully demonstrated or ground-water monitoring and institutional controls are found to be ineffective. The contingent remedies are dechlorination for the soils; and extraction, treatment and discharge to a publicly-owned treatment works for the ground water.

In March 1993, WDOE issued a Cleanup Action Plan for the site (*WDOE, 1993a*). The Cleanup Action Plan specifies PCBs and petroleum hydrocarbons as indicator chemicals for site cleanup and specifies the following cleanup levels:

<u>Medium</u>	<u>PCBs</u>	<u>Petroleum Hydrocarbons</u>
Shallow Soils (\leq 15 ft deep)	10 mg/kg	200 mg/kg
Deep Soils ($>$ 15 ft deep)	60 mg/kg	200 mg/kg
Ground Water	0.1 μ g/L	not applicable

The Cleanup Action Plan specifies that the cleanup action for soils is treatment by vitrification and that the cleanup action for ground water is compliance monitoring and institutional controls; which are the preferred remedies identified in the feasibility study. The Cleanup Action Plan also specifies the same contingent remedies identified in the feasibility study. In-situ stabilization of some of the deep soils (grouting of soils below the West Dry Well from about 30 feet below ground

surface to about 10 feet into the saturated zone) will also be performed because it is unlikely that the ISV technology will be sufficiently developed for treatment of soils at such depths.

The Consent Decree between GE and WDOE (WDOE, 1993b) outlines GE's responsibilities in performing the cleanup, including a specific scope and schedule of activities and deliverables. This document is a required deliverable under the Consent Decree.

Section 2

SUMMARY OF CLEANUP AND ACTION LEVELS

A summary of cleanup levels for soil and ground water and action levels for air are provided in Sections 2.1 and 2.2, respectively.

2.1 Indicator Parameters and Cleanup Levels

As previously mentioned, the indicator chemicals for the GE-Spokane site are PCBs and total petroleum hydrocarbons (TPH). Cleanup levels associated with each chemical are provided below.

<u>Medium</u>	<u>PCBs</u>	<u>TPH</u>
Shallow Soils (\leq 15 ft deep)	10 mg/kg	200 mg/kg
Deep Soils ($>$ 15 ft deep)	60 mg/kg	200 mg/kg
Ground Water	0.1 μ g/L	not applicable

Because a cleanup level is given for total PCBs only, and PCB concentrations are reported as Aroclors, PCB compliance calculations shall use the sum of all Aroclors detected in the samples.

2.2 Action Levels

The action levels for air are provided in Table 2-1. The action levels have been set at one-half the value of the permissible exposure limits in *General Occupational Health Standards, Washington Administrative Code (WAC) 296-62 (WISHA, 1991)*.

Section 3

PROCEDURES FOR DEMONSTRATING COMPLIANCE WITH CLEANUP AND ACTION LEVELS

This section presents the statistical parameters to be used to demonstrate compliance with the cleanup levels at the GE-Spokane site. This section also provides the procedures for addressing measurements below detection limits, for comparing soil and ground-water data with cleanup levels, and for comparing air data with action levels.

3.1 Statistical Parameters

According to MTCA [*Washington Administrative Code (WAC) 173-340-740(7)(d)(i)*] (WDOE, 1990), the appropriate statistical method for evaluating compliance with cleanup levels based on chronic or carcinogenic effects is to compare the upper confidence limit (UCL) of the mean of the sample concentrations. MTCA (WAC 173-340-200) (WDOE, 1990) specifies that the null hypothesis for evaluating compliance is that chemical concentrations at the site exceed the cleanup level. Since there is only one possibility for the alternative hypothesis (chemical concentrations do not exceed cleanup levels), the upper confidence limit is one-sided. Thus, the one-sided upper confidence limit of the mean is used for comparison with cleanup levels.

The UCL is defined as $100 \times (1-\alpha)$. The statistical parameters to be used to determine the UCL are: α , the false positive rate or Type I error, and the confidence limit. The false positive rate is the rate at which the site may be assumed clean when in fact it is not. The value for α and the confidence limit are specified in the *Statistical Guidance for Ecology Site Managers* (WDOE, 1992), as $\alpha = 0.05$ and 95 percent, respectively ($100 \times (1-\alpha) = 95$ percent).

In order to calculate whether a statistically significant number of samples has been collected, it is necessary to specify a false negative rate (β), or Type II error. The false negative rate indicates that additional cleanup is required when in fact it is not needed. As MTCA does not specify the Type II error, a value of 0.2 was selected.

To summarize, the values for α , β and the confidence interval used in the procedures in this Data Management Plan are:

$\alpha = 0.05$ or Type I error level of 5 percent;
 $\beta = 0.2$ or Type II error level of 20 percent; and
 $100(1-\alpha) = 95$ percent confidence interval.

3.2 Procedures for Values Below Detection Limits

Censored data sets (data sets that include one or more values below the detection limit or below the practical quantitation limit (PQL)) will be evaluated using the procedures provided in Supplement S-6 of *Statistical Guidance for Ecology Site Managers* (WDOE, 1993). A simple substitution for censored values will only be appropriate in cases where less than 15 percent of the data are non-detects or less than the PQL. In this case, concentrations below the detection limit will be assigned a value equal to one-half the detection limit of the method being used. Measurements above the detection limit but below the PQL will be assigned a value equal to the method detection limit. Methods for evaluating data sets in cases where greater than 15 percent of the data are censored are described in Section 3.4 and Section 3.5 for soil and ground-water data, respectively.

3.3 Procedures for Determining the Distribution of Compliance Data

The procedures for determining the distribution of compliance data are described below. One of two methods will be used: normal probability plot analyses or the W test.

3.3.1 Normal Probability Plot Analyses

The procedure for performing a normal probability plot analysis is as follows (WDOE, 1993d):

Step 1. **List the values from lowest to highest and assign a rank to each value.** Substitute half the detection limit for non-detects or the method detection limit for values below PQLs.

Step 2. **Calculate a score for each uncensored value.**

$$\text{score}_i = \Phi^{-1}[(i - 3/8) / (n + 0.25)]$$

where:

Φ^{-1} = the inverse of the standard normal cumulative distribution from Table 3-1;

i = the rank of the value; and

n = the total number of data values (both censored and uncensored).

Step 3. **Use the uncensored values and the corresponding scores to calculate the least-squares linear regression equation and the correlation coefficient, r .** The linear regression equation and correlation coefficient, r , will be determined using a calculator or a personal computer.

(1) Proceed only if the analysis of variance (ANOVA) F-value is significant at the $p = 0.05$ level.

- (2) If the square of the correlation coefficient (r^2) for the analysis of the log-transformed values is 0.9 or higher, assume that the data are lognormally distributed.
- (3) If the lognormal distribution is rejected, then if r^2 for the analysis of the untransformed values is 0.9 or higher, assume that the data are normally distributed. Otherwise reject the normal distributions.

3.3.2 W Test

The "W test" will be used to test whether data differ significantly from a normal distribution (WDOE, 1992). If the W test does not show that the data differ significantly from normal, a normal distribution can be assumed. The W test is appropriate for fewer than 50 samples.

- (1) Calculate d , the denominator of the W test statistic, using the following formula:

$$d = \sum_{i=1}^n (x_i - \bar{x})^2$$

where:

n = The total number of samples; and

x_i = The individual sample values.

- (2) Sort sample data from smallest to largest, and assign a rank to each value.

- (3) Determine r :

$r = n/2$ if n is even; and

$r = (n-1)/2$ if n is odd.

- (4) Determine the coefficients a_1, a_2, \dots, a_r , for the number of samples, n , using Table 3-2.

- (5) Calculate W using the following equation:

$$W = \frac{1}{d} \left[\sum_{i=1}^r a_i (x_{n-i+1} - x_i) \right]^2$$

where:

x_i = The value of the i th ranked data; and

a_i = Coefficient from Table 3-2.

- (6) Find the value of W in Table 3-3 for a confidence level of 95 percent, $\alpha = 0.05$, and the sample size, n . If the W calculated in Step 5 is less than the value found in Table 3-3, the data are not normally distributed. If the W from Step 5 is greater than the tabulated value for W , it can be assumed that the data are normally distributed.

To test data for lognormality, \log_e -transform the data set and perform (1) through (6) on the transformed data.

3.4 Statistical Procedures for Evaluating Soil Data

The procedures described below address the evaluation of data generated for both verification samples and confirmation samples. Verification samples refer to samples collected and analyzed in the field by the onsite laboratory. Confirmation samples refer to samples analyzed by the offsite laboratory.

Worksheets have been prepared for the use of the field sampling team based upon the guidance provided in *Methods for Evaluating the Attainment of Cleanup Standards* (U.S. EPA, 1989). All completed worksheets will be checked by a qualified individual other than the originator and retained in the project records.

The methods for determining compliance with cleanup levels are summarized below. The methods are dependent on the percentage of censored data in the data set.

3.4.1 Case 1 - Less Than 15 Percent of Data are Censored

In Case 1, where no more than 15 percent of the data set are censored, concentrations below the detection limit will be assigned a value equal to one-half the detection limit of the method being used. To concentrations above the detection limit but below the PQLs, a value equal to the detection limit will be assigned. The UCL on the mean is then calculated using the t-statistic for normally distributed data and Land's equation for lognormally distributed data. Acceptance calculations for data that fall into the Case 1 category are described below. Acceptance calculations for verification samples are discussed in Section 3.4.1.1 and final acceptance calculations for area samples are discussed in Section 3.4.1.2.

3.4.1.1 Area Acceptance Calculations for Verification Samples

This section describes the step-by-step procedure for determining whether the required number of verification samples have been collected and whether the

cleanup action has attained site cleanup levels for a given area. Areas to be sampled are discussed in further detail in Section 4 of the Soil Sampling and Analysis Plan. The procedures outlined below for calculating a one-sided UCL of the mean is based on procedures provided in *Statistical Guidance for Ecology Site Managers* (WDOE, 1992).

The procedures presented below outline the steps to be used for area acceptance in conjunction with Worksheet 1 for PCBs and Worksheet 2 for TPH.

Step 1. **Compile results.** After the verification samples have been analyzed by the onsite laboratory, list the concentration and the associated sample number for each sample taken in the area. If any single sample value is greater than two times the soil cleanup level, initiate further excavation in the area of the exceedance. If more than 10 percent of the samples exceed the cleanup level, initiate further excavation in the appropriate areas. If the criteria listed above have been met, proceed to Step 2.

Step 2. **Calculate mean of sample results.** Calculate the mean of the sample results for all the samples taken in the area.

The following formula will be used to calculate this parameter:

$$\bar{x} = \frac{\sum X}{n}$$

where:

\bar{x} = Mean of sample variable;
 X = Individual sample variable; and
 n = Number of samples.

- Step 3. **Calculate standard deviation.** Calculate the standard deviation of the sample results for all the samples taken in the area.

$$S = \sqrt{\frac{\sum (\bar{x} - X)^2}{n - 1}}$$

where:

\bar{x} = Mean of sample variable;
 X = Individual sample variable;
 n = Number of samples; and
 S = Standard deviation of the sample variable.

A scientific calculator or portable personal computer may be used to calculate the mean and standard deviation directly.

- Step 4. **Calculate difference in units of standard deviation.** Calculate " τ " of the sample results for the area. The parameter τ expresses the difference in units of standard deviation and is expressed as:

$$\tau = \frac{(C_s - \bar{x})}{S}$$

where:

τ = Difference in units of standard deviation;
 C_s = Cleanup level;
 \bar{x} = Mean of sample variable; and
 S = Standard deviation of the sample variable.

- Step 5. **Determine required number of samples.** Determine the required number of samples to obtain a false positive rate of 5 percent ($\alpha = 0.05$) and a false negative rate of 20 percent ($\beta = 0.20$). The calculations will be performed for PCBs and TPH.

Calculate the number of samples required for verification of successful cleanup of the area using the formula below.

$$n_d = \frac{(z_{1-\beta} + z_{1-\alpha})^2}{\tau^2}$$

where:

n_d = Required number of samples;

$z_{1-\beta} = 0.842$ and $z_{1-\alpha} = 1.645$, the critical values for the normal distribution with probabilities $1-\alpha$ and $1-\beta$, ($\alpha = 0.05$), ($\beta = 0.20$); and

τ = Difference in units of standard deviation.

Test the results to determine if a sufficient number of samples have been taken to obtain a false positive rate of 5 percent ($\alpha = 0.05$) and a false negative rate of 20 percent ($\beta = 0.20$). If sufficient samples have not been taken, either take additional samples or initiate further cleanup.

Step 6.

Determine whether verification sample results are below cleanup levels. Use the method outlined below to determine acceptance of a sample area for PCBs and TPH separately. Calculate the UCL of the mean:

- (1) Look up the appropriate t value in Table 3-4. The t value is determined by the value of a 95 percent confidence interval ($t_{0.95}$), and the degrees of freedom (df), which is one less than the number of samples, n ; and

- (2) Use the formula below to calculate the UCL:

$$UCL = \bar{x} + t_{\alpha, n-1} \frac{S}{\sqrt{n}}$$

where:

\bar{x} = Sample mean;

S = Sample standard deviation;

n = Number of samples; and

t = Value of the parameter t from Table 3-4, based on a 95 percent confidence interval ($t_{0.95}$) and n-1 degrees of freedom.

With the input values of \bar{x} , S, n, and t, the UCL may be calculated using a personal computer.

- (3) Compare the UCL of the mean for PCBs and TPH with their respective cleanup levels for a given depth. If the UCL of the mean for PCBs or TPH is greater than their respective cleanup levels at a given depth, initiate additional cleanup. If the UCL of the mean for the verification samples analyzed for PCBs is less than or equal to the cleanup level for shallow soils (at or above 15 feet) of 10 mg/kg or the cleanup level for deep soils (below 15 feet) of 60 mg/kg, the area meets cleanup goals for PCBs at the site. If the UCL of the mean for the verification samples analyzed for TPH is less than or equal to the cleanup level of 200 mg/kg, the area meets cleanup goals for TPH.

- Step 7. **Send confirmation samples to the offsite laboratory.** Randomly select ten percent of the verification samples for submission to the offsite laboratory for confirmation analysis.

3.4.1.2 Final Acceptance Calculations for Area Samples

The procedure for determining if soil data meet the cleanup level has been adapted from the *Statistical Guidance for Ecology Site Managers* (WDOE, 1992).

The procedures described below address all samples collected within a given area (i.e., combined verification and confirmation sample results). The procedures will be used to evaluate whether a given area has attained soil cleanup levels for PCBs and TPH. Areas to be sampled are discussed in further detail in Section 4 of the Soil Sampling and Analysis Plan.

- Step 1. **Compile results.** List the concentration and associated sample number for each verification and confirmation sample taken. For the PCB confirmation samples, the concentration used to calculate compliance should be the sum of the Aroclors detected. If any single sample value is greater than two times the soil cleanup level, initiate further excavation in the area of the exceedance. If more than ten percent of the samples exceed the cleanup level, initiate further excavation in the appropriate areas. If the criteria listed above have been met, proceed to Step 2.
- Step 2. **Determine whether data are normally or lognormally distributed.** Use the procedures outlined in Section 3.3.
- Step 3. **Calculate the UCL of the mean for both PCBs and TPH.** Calculate the UCL of the mean using the appropriate equation below based on the distribution of the data. Use H values and the method of Land (WDOE, 1992) if data are lognormally distributed.

UCL of the Mean for Normally Distributed Data

Use the procedure outlined in Step 6 in Section 3.4.1.1. Refer to Worksheet 3 (PCBs) and Worksheet 4 (TPH) for instructions for calculating the one-sided 95 percent UCL for normally distributed data.

UCL of the Mean for Lognormally Distributed Data

- 1) Calculate the mean (\bar{y}) and standard deviation (S_y) of the \log_e -transformed data using the equations provided previously.
- 2) Look up the appropriate H value in Table 3-5. The value of the H parameter depends on the number of samples, n, and on the variability of the sample data, measured by the standard deviation of the \log_e -transformed data, S_y .
- 3) For a 95 percent one-sided confidence interval ($\alpha = 0.05$), the UCL is calculated by:

$$UCL = \exp\left(\bar{y} + 0.5 (S_y)^2 + \frac{S_y H_{1-\alpha}}{\sqrt{n-1}}\right)$$

where:

exp = e raised to the indicated power;

\bar{y} = Mean of the \log_e -transformed data;

S_y = Standard deviation of the \log_e -transformed data;

n = Number of samples;

α = Significance level (0.05); and

H = H value from Table 3-5.

Refer to Worksheet 5 (PCBs) and Worksheet 6 (TPH) for detailed instructions for calculating the one-sided 95 percent UCL for the lognormal mean using Land's method.

- 4) Compare the UCL of the mean for PCBs and TPH with their respective cleanup levels for a given depth. If the UCL of the mean for the verification and confirmation samples analyzed for PCBs is less than or equal to the cleanup level for shallow soils of 10 mg/kg or the cleanup level for deep soils of 60 mg/kg, the area meets cleanup goals for PCBs. If the UCL of the mean for the verification and confirmation samples analyzed for TPH is less than or equal to the cleanup level of 200 mg/kg, the area meets cleanup goals for TPH.

Step 4. **Determine if the area requires further cleanup.** If the UCL of the mean is greater than the respective cleanup levels for PCBs and/or TPH, additional cleanup of the area is required.

3.4.2 Case 2 - Between 15 and 50 Percent of Data are Censored

In Case 2, where censored values are between 15 and 50 percent, Cohen's method is used to adjust for data below detection limits. Cohen's method is used to determine a method-adjusted mean and standard deviation for log-transformed and untransformed data if the data set is lognormally or normally distributed, respectively (*Gilbert, 1987*). The method-adjusted mean and standard deviation are then used in calculating the UCL on the mean.

Step 1. Assume that the data are lognormally distributed. Compute h .

$$h = (n-k)/n$$

where:

h = proportion of measurements below the detection limit;

n = the total number of measurements x_i ; and

k = number out of n that are above the detection limit.

Step 2. Compute the sample mean and variance of the k measurements above the detection limit.

$$\bar{y} = \frac{1}{k} \sum_{i=1}^k y_i \quad \text{and}$$

$$s^2 = \frac{1}{k} \sum_{i=1}^k (y_i - \bar{y})^2$$

where:

\bar{y} = sample mean of the k measurements above the detection limit;

$y_i = \ln x_i$;

k = number out of n that are above the detection limit; and

s^2 = sample variance of k measurements above the detection limit.

Step 3. Calculate the parameter, $\hat{\gamma}$.

$$\hat{\gamma} = \frac{s^2}{(\bar{y} - y_0)^2}$$

where:

s^2 = variance of k measurements above the detection limit;

\bar{y} = sample mean of k measurements above the detection limit; and

y_0 = ln of the detection limit.

Step 4. Estimate $\hat{\lambda}$ from Table 3-6 based on the calculated h and $\hat{\gamma}$ values. Interpolate in the horizontal and vertical planes if necessary.

Step 5. Estimate the mean, $\hat{\mu}_y$, and variance, $\hat{\sigma}_y^2$, of the log-transformed data. Determine the standard deviation by taking the square root of the variance.

$$\hat{\mu}_y = \bar{y} - \hat{\lambda}(\bar{y} - y_0); \text{ and}$$

$$\hat{\sigma}_y^2 = s^2 + \hat{\lambda}(\bar{y} - y_0)^2.$$

Step 6. Estimate the mean and variance of the lognormal distribution. Determine the standard deviation by taking the square root of the variance.

$$\hat{\mu} = \exp\left(\hat{\mu}_y + \frac{\hat{\sigma}_y^2}{2}\right); \text{ and}$$

$$\hat{\sigma}^2 = \hat{\mu}^2 \left[\exp\left(\hat{\sigma}_y^2\right) - 1 \right]$$

If the censored data set is from a normal distribution, replace $y_i = \ln x_i$ and $y_0 = \ln$ of the detection limit with the untransformed x_i and detection limit, respectively.

Step 7. Calculate the UCL on the Mean.

UCL on the Mean for Normally Distributed Data

Use the procedures outlined in Step 6 of Section 3.4.1.1. Enter the adjusted mean and standard deviation calculated above for the corresponding parameters of the UCL equation.

UCL on the Mean for Lognormally Distributed Data

Use the procedure outlined for lognormally distributed data in Step 3 of Section 3.4.1.2. Enter the adjusted mean and standard deviation calculated above for the corresponding parameters in Land's equation.

Step 8. Compare the UCL with the Cleanup Level.

Use the procedure outlined for soils in Step 3 of Section 3.4.1.2.

3.4.3 Case 3 - Greater Than 50 Percent of Data are Censored

In Case 3, where censored values comprise more than 50 percent of the data set, the largest value of the data set is used as the UCL.

3.5 Statistical Procedures for Evaluating Ground-Water Data

The procedure for determining if ground-water data meet the cleanup level has been adapted from the *Statistical Guidance for Ecology Site Managers* (WDOE, 1992). The following procedures will be performed for each well in the monitoring network.

The methods for determining whether PCBs in ground water are below cleanup levels are dependent on the percentage of censored data in the data set and are described below.

3.5.1 Case 1 - Less than 15 Percent of Data are Censored

In Case 1, where no more than 15 percent of the data set are censored, concentrations below the detection limit will be assigned a value equal to one-half the detection limit of the method being used. To concentrations above the detection limit but below the PQLs, a value equal to the detection limit will be assigned. The UCL on the mean is then calculated using the t-statistic for normally distributed data and Land's equation for lognormally distributed data.

- Step 1. **Compile results.** List the concentration (sum of the Aroclors detected) and associated sample number for each ground-water sample taken from a single well in the monitoring network. A minimum of eight samples is required (i.e., eight quarterly rounds of sampling). No single sample value shall be greater than two times the ground-water cleanup level and less than ten percent of the sample results shall exceed the cleanup level for a successful cleanup of the site.
- Step 2. **Determine whether the data are normally or lognormally distributed.** Use the procedures described in Section 3.3.

Step 3.

Calculate the UCL of the mean. Calculate the UCL of the mean for PCBs using the appropriate equation below based on the distribution of the data. Use H values and the method of Land (WDOE, 1992) if data are lognormally distributed.

UCL of the Mean for Normally Distributed Data

- 1) Calculate the mean (\bar{x}) and standard deviation (S) of the ground-water data using the same equations provided in Section 3.3.1 for soil.
- 2) Look up the appropriate t value in Table 3-4. The t value is determined by the value of α of 0.05, and the degrees of freedom (df), which is one less than the number of samples, n.
- 3) Use the formula below to calculate the UCL:

$$UCL = \bar{x} + t_{1-\alpha, n-1} \frac{S}{\sqrt{n}}$$

where:

\bar{x} = Sample mean;

S = Sample standard deviation;

n = Number of samples; and

t = Value of the parameter t from Table 3-4, based on a 95 percent confidence interval ($t_{0.95}$) and n-1 degrees of freedom.

Refer to Worksheet 7 for detailed instructions for calculating the one-sided 95 percent UCL of the mean for PCBs in ground water or with the input values of \bar{x} , S, n, and t, the UCL may be calculated using a personal computer.

- 4) Compare the UCL of the mean for PCBs with the cleanup level of 0.1 µg/l. If the UCL of the mean for PCBs is less than or equal to the cleanup level of 0.1 µg/L, the well meets cleanup goals for PCBs in ground water. If the UCL of the mean is greater than the cleanup level, additional monitoring of the well is necessary.

UCL of the Mean for Lognormally Distributed Data

- 1) Calculate the mean (\bar{y}) and standard deviation (S_y) of the \log_e -transformed data using the equations provided for soil data in Section 3.4.1.2.
- 2) Look up the appropriate H value in Table 3-5. The value of the H parameter depends on the number of samples, n, and on the variability of the sample data, measured by the standard deviation of the \log_e -transformed data, S_y .
- 3) For a 95 percent one-sided confidence interval ($\alpha = 0.05$), the UCL is calculated by:

$$UCL = \exp\left(\bar{y} + 0.5 (S_y)^2 + \frac{S_y H_{1-\alpha}}{\sqrt{n-1}}\right)$$

where:

\exp = e raised to the indicated power;

\bar{y} = Mean of the \log_e -transformed data;

S_y = Standard deviation of the \log_e -transformed data;

n = Number of samples;

α = Significance level (0.05); and

H = H value from Table 3-5.

Refer to Worksheet 8 for detailed instructions for calculating the one-sided 95 percent UCL for the lognormal mean using Land's method for PCBs in ground-water.

- 4) Compare the UCL of the mean for PCBs with the cleanup level of 0.1 $\mu\text{g/L}$. If the UCL of the mean for PCBs is less than or equal to the cleanup level of 0.1 $\mu\text{g/L}$, the well meets cleanup goals for PCBs in ground water. If the UCL of the mean is greater than the cleanup level, additional monitoring of the well is necessary.

3.5.2 Case 2 - Between 15 and 50 Percent of Data are Censored

In Case 2, where censored values are between 15 and 50 percent, Cohen's method is used to adjust for ground-water data below detection limits. Cohen's method is used to determine a method-adjusted mean and standard deviation for log-transformed and untransformed data if the data set is lognormally or normally distributed, respectively. Once the method-adjusted mean and standard deviation are determined, the UCL on the mean is then calculated using procedures described in Section 3.4.2.

The UCL on the mean is then compared with the cleanup level for PCBs of 0.1 $\mu\text{g/L}$. If the UCL on the mean for PCBs is less than or equal to the cleanup level, the well meets cleanup goals for PCBs in ground water. If the UCL is greater than the cleanup level, additional monitoring of the well is necessary.

3.5.3 Case 3 - Greater Than 50 Percent of Data are Censored

In Case 3, where censored values comprise more than 50 percent of the ground-water data set for a monitoring well, the largest value of the data set is used as the UCL.

The UCL on the mean is then compared with the cleanup level for PCBs of 0.1 $\mu\text{g}/\text{l}$. If the UCL on the mean for PCBs is less than or equal to the cleanup level, the well meets cleanup goals for PCBs in ground water. If the UCL is greater than the cleanup level, additional monitoring of the well is necessary.

3.6 Procedures for Comparing Air Data to Action Levels

Analytical results of air monitoring samples will be compared with action levels directly. If air monitoring results are greater than action levels provided in Table 2-1, the level of personal protection (i.e., from Level D to Level C) will be upgraded, as discussed in Section 6 of the Health and Safety Plan.

Section 4

SCHEDULE FOR FORMAL DATA REVIEWS

Soil and air data will be made available to WDOE for formal review in the Cleanup Action Report. The schedule for submittal of the Cleanup Action Report is provided in Section 4.1 of the Summary Cleanup Action Planning Report. WDOE will receive the preliminary soil and air data for review in the monthly progress reports as discussed in Section 7.5.4 of the Quality Assurance Project Plan.

Ground-water data will be made available to WDOE for formal review after each quarterly ground-water monitoring round. A trend analysis of ground-water data will also be performed annually and presented to WDOE in the annual ground-water monitoring report.

Section 5

ELECTRONIC FORMAT FOR DATA SUBMITTAL

This section addresses the electronic format for data submittal of compliance monitoring data.

5.1 Database Format

All soil and ground-water analytical data generated during the cleanup action will be tabulated, encoded and entered into a computer database. Ground-water level data will also be tabulated, encoded and entered into a database. The analytical database will also include quality assurance data. Location and descriptive information of all sample locations and water-level measurement locations will be tabulated, encoded and entered into the database. Database fields will follow the format and units specified in the *Cleanup Information No. 91-1: Ground Water, Soil, Sludge, and Sediment Data* (WDOE, 1993c).

Because of the limited number of air and soil-gas data to be generated compared to soil or ground-water data, these data will be tabulated but will not be stored in a database.

5.2 Electronic Data Submittal

Information contained in the database will be submitted to WDOE on MS-DOS (version 5) or compatibly formatted diskette. The diskette will contain a Site Description File, Field Sample File and Laboratory Sample File as required in the above mentioned document (WDOE, 1993c). Two copies of the diskette, along with a backup hard copy, will be provided to WDOE.

Once data have been reviewed and/or validated, soil, soil-gas and air data will be transmitted in the monthly progress reports submitted to WDOE. Electronic

ground-water data will be transmitted with each quarterly monitoring report. Planned data submittal schedules and progress updates can be made available to WDOE upon request.

Section 6

REFERENCES

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Washington Industrial Safety and Health Act, 1991, *General Occupational Health Standards*, WAC 296-62, Volume 1, Parts A-I.

TABLES

TABLE 1-1

CROSS-REFERENCE TO CONSENT DECREE REQUIREMENTS

<i>CONSENT DECREE REQUIREMENT</i>	<i>SECTION</i>
Summary of indicator parameters and cleanup levels.	2.1
Summary of action levels.	2.2
Procedures for measurements below the detection limit or PQL.	3.2
Statistical parameters and methods.	3
Schedule for formal data reviews.	4
Electronic format for data submittal.	5

TABLE 2-1

ACTION LEVELS FOR AIR MONITORING DATA

PARAMETER	ACTION LEVEL (1)
PCBs	0.25 mg/m ³
Benzene	0.5 ppm
Ethyl benzene	50 ppm
Toluene	50 ppm
Tetrachloroethene	12 ppm
Trichloroethene	25 ppm
Nuisance Dust, total	5.0 mg/m ³
Nuisance Dust, respirable	2.5 mg/m ³
Explosive/flammable gases and vapor	10% LEL (2)
Oxygen content	19.2% O ₂

Notes:

- (1) Action levels are set at one-half of the WISHA permissible exposure limits.
(2) LEL = Lower explosive limit.

TABLE 3-1

CUMULATIVE NORMAL DISTRIBUTION
(VALUES OF p CORRESPONDING TO Z_p FOR THE NORMAL CURVE)

Z_p	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5674	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9736	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

TABLE 3-2

COEFFICIENTS a_i FOR THE SHAPIRO-WILK W TEST FOR NORMALITY

$f \backslash n$	2	3	4	5	6	7	8	9	10
1	0.7071	0.7071	0.6872	0.6646	0.6431	0.6233	0.6052	0.5888	0.5739
2	-	0.0000	0.1677	0.2413	0.2806	0.3031	0.3164	0.3244	0.3291
3	-	-	-	0.0000	0.0875	0.1401	0.1743	0.1976	0.2141
4	-	-	-	-	-	0.0000	0.0561	0.0947	0.1224
5	-	-	-	-	-	-	-	0.0000	0.0399

$f \backslash n$	11	12	13	14	15	16	17	18	19	20
1	0.5601	0.5475	0.5359	0.5251	0.5150	0.5056	0.4968	0.4886	0.4808	0.4734
2	0.3315	0.3325	0.3325	0.3318	0.3306	0.3290	0.3273	0.3253	0.3232	0.3211
3	0.2260	0.2347	0.2412	0.2460	0.2495	0.2521	0.2540	0.2553	0.2561	0.2565
4	0.1429	0.1586	0.1707	0.1802	0.1878	0.1939	0.1988	0.2027	0.2059	0.2085
5	0.0695	0.0922	0.1099	0.1240	0.1353	0.1447	0.1524	0.1587	0.1641	0.1686
6	0.0000	0.0303	0.0539	0.0727	0.0880	0.1005	0.1109	0.1197	0.1271	0.1334
7	-	-	0.0000	0.0240	0.0433	0.0593	0.0725	0.0837	0.0932	0.1013
8	-	-	-	-	0.0000	0.0196	0.0359	0.0496	0.0612	0.0711
9	-	-	-	-	-	-	0.0000	0.0163	0.0303	0.0422
10	-	-	-	-	-	-	-	-	0.0000	0.0140

$f \backslash n$	21	22	23	24	25	26	27	28	29	30
1	0.4643	0.4590	0.4542	0.4493	0.4450	0.4407	0.4366	0.4328	0.4291	0.4254
2	0.3185	0.3156	0.3126	0.3098	0.3069	0.3043	0.3018	0.2992	0.2968	0.2944
3	0.2578	0.2571	0.2563	0.2554	0.2543	0.2533	0.2522	0.2510	0.2499	0.2487
4	0.2119	0.2131	0.2139	0.2145	0.2148	0.2151	0.2152	0.2151	0.2150	0.2148
5	0.1736	0.1764	0.1787	0.1807	0.1822	0.1836	0.1848	0.1857	0.1864	0.1870
6	0.1399	0.1443	0.1480	0.1512	0.1539	0.1563	0.1584	0.1601	0.1616	0.1630
7	0.1092	0.1150	0.1201	0.1245	0.1283	0.1316	0.1346	0.1372	0.1395	0.1415
8	0.0804	0.0878	0.0941	0.0997	0.1046	0.1089	0.1128	0.1162	0.1192	0.1219
9	0.0530	0.0618	0.0696	0.0764	0.0823	0.0876	0.0923	0.0965	0.1002	0.1036
10	0.0263	0.0368	0.0459	0.0539	0.0610	0.0672	0.0728	0.0778	0.0822	0.0862
11	0.0000	0.0122	0.0228	0.0321	0.0403	0.0476	0.0540	0.0598	0.0650	0.0697
12	-	-	0.0000	0.0107	0.0200	0.0284	0.0358	0.0424	0.0483	0.0537
13	-	-	-	-	0.0000	0.0094	0.0178	0.0253	0.0320	0.0381
14	-	-	-	-	-	-	0.0000	0.0084	0.0159	0.0227
15	-	-	-	-	-	-	-	-	0.0000	0.0076

(From Gilbert, 1987)

TABLE 3-2 cont.

COEFFICIENTS a_j FOR THE SHAPIRO-WILK W TEST FOR NORMALITY

$f \backslash n$	31	32	33	34	35	36	37	38	39	40
1	0.4220	0.4188	0.4156	0.4127	0.4096	0.4068	0.4040	0.4015	0.3989	0.3964
2	0.2921	0.2898	0.2876	0.2854	0.2834	0.2813	0.2794	0.2774	0.2755	0.2737
3	0.2475	0.2462	0.2451	0.2439	0.2427	0.2415	0.2403	0.2391	0.2380	0.2368
4	0.2145	0.2141	0.2137	0.2132	0.2127	0.2121	0.2116	0.2110	0.2104	0.2098
5	0.1874	0.1878	0.1880	0.1882	0.1883	0.1883	0.1883	0.1881	0.1880	0.1878
6	0.1641	0.1651	0.1660	0.1667	0.1673	0.1678	0.1683	0.1686	0.1689	0.1691
7	0.1433	0.1449	0.1463	0.1475	0.1487	0.1496	0.1505	0.1513	0.1520	0.1526
8	0.1243	0.1265	0.1284	0.1301	0.1317	0.1331	0.1344	0.1356	0.1366	0.1376
9	0.1066	0.1093	0.1116	0.1140	0.1160	0.1179	0.1196	0.1211	0.1225	0.1237
10	0.0899	0.0931	0.0961	0.0988	0.1013	0.1036	0.1056	0.1075	0.1092	0.1108
11	0.0739	0.0777	0.0812	0.0844	0.0873	0.0900	0.0924	0.0947	0.0967	0.0986
12	0.0585	0.0629	0.0669	0.0706	0.0739	0.0770	0.0798	0.0824	0.0848	0.0870
13	0.0435	0.0485	0.0530	0.0572	0.0610	0.0645	0.0677	0.0706	0.0733	0.0759
14	0.0289	0.0344	0.0395	0.0441	0.0484	0.0523	0.0559	0.0592	0.0622	0.0651
15	0.0144	0.0206	0.0262	0.0314	0.0361	0.0404	0.0444	0.0481	0.0515	0.0546
16	0.0000	0.0068	0.0131	0.0187	0.0239	0.0287	0.0331	0.0372	0.0409	0.0444
17	-	-	0.0000	0.0062	0.0119	0.0172	0.0220	0.0264	0.0305	0.0343
18	-	-	-	-	0.0000	0.0057	0.0110	0.0158	0.0203	0.0244
19	-	-	-	-	-	-	0.0000	0.0053	0.0101	0.0146
20	-	-	-	-	-	-	-	-	0.0000	0.0049

$f \backslash n$	41	42	43	44	45	46	47	48	49	50
1	0.3940	0.3917	0.3894	0.3872	0.3850	0.3830	0.3808	0.3789	0.3770	0.3751
2	0.2719	0.2701	0.2684	0.2667	0.2651	0.2635	0.2620	0.2604	0.2589	0.2574
3	0.2357	0.2345	0.2334	0.2323	0.2313	0.2302	0.2291	0.2281	0.2271	0.2260
4	0.2091	0.2085	0.2078	0.2072	0.2065	0.2058	0.2052	0.2045	0.2038	0.2032
5	0.1876	0.1874	0.1871	0.1868	0.1865	0.1862	0.1859	0.1855	0.1851	0.1847
6	0.1693	0.1694	0.1695	0.1695	0.1695	0.1695	0.1695	0.1693	0.1692	0.1691
7	0.1531	0.1535	0.1539	0.1542	0.1545	0.1548	0.1550	0.1551	0.1553	0.1554
8	0.1384	0.1392	0.1398	0.1405	0.1410	0.1415	0.1420	0.1423	0.1427	0.1430
9	0.1249	0.1259	0.1269	0.1278	0.1286	0.1293	0.1300	0.1306	0.1312	0.1317
10	0.1123	0.1136	0.1149	0.1160	0.1170	0.1180	0.1189	0.1197	0.1205	0.1212
11	0.1004	0.1020	0.1035	0.1049	0.1062	0.1073	0.1085	0.1095	0.1105	0.1113
12	0.0891	0.0909	0.0927	0.0943	0.0959	0.0972	0.0986	0.0998	0.1010	0.1020
13	0.0782	0.0804	0.0824	0.0842	0.0860	0.0876	0.0892	0.0906	0.0919	0.0932
14	0.0677	0.0701	0.0724	0.0745	0.0765	0.0783	0.0801	0.0817	0.0832	0.0846
15	0.0575	0.0602	0.0628	0.0651	0.0673	0.0694	0.0713	0.0731	0.0748	0.0764
16	0.0476	0.0506	0.0534	0.0560	0.0584	0.0607	0.0628	0.0648	0.0667	0.0685
17	0.0379	0.0411	0.0442	0.0471	0.0497	0.0522	0.0546	0.0568	0.0588	0.0608
18	0.0283	0.0318	0.0352	0.0383	0.0412	0.0439	0.0465	0.0489	0.0511	0.0532
19	0.0188	0.0227	0.0263	0.0296	0.0328	0.0357	0.0385	0.0411	0.0436	0.0459
20	0.0094	0.0136	0.0175	0.0211	0.0245	0.0277	0.0307	0.0335	0.0361	0.0386
21	0.0000	0.0045	0.0087	0.0126	0.0163	0.0197	0.0229	0.0259	0.0288	0.0314
22	-	-	0.0000	0.0042	0.0081	0.0118	0.0153	0.0185	0.0215	0.0244
23	-	-	-	-	0.0000	0.0039	0.0076	0.0111	0.0143	0.0174
24	-	-	-	-	-	-	0.0000	0.0037	0.0071	0.0104
25	-	-	-	-	-	-	-	-	0.0000	0.0035

(From Gilbert, 1987)

TABLE 3-3

QUANTILES OF THE SHAPIRO-WILK W TEST FOR NORMALITY

n	W _{0.01}	W _{0.02}	W _{0.05}	W _{0.10}	W _{0.50}
3	0.753	0.756	0.767	0.789	0.959
4	0.687	0.707	0.748	0.792	0.935
5	0.686	0.715	0.762	0.806	0.927
6	0.713	0.743	0.788	0.826	0.927
7	0.730	0.760	0.803	0.838	0.928
8	0.749	0.778	0.818	0.851	0.932
9	0.764	0.791	0.829	0.859	0.935
10	0.781	0.806	0.842	0.869	0.938
11	0.792	0.817	0.850	0.876	0.940
12	0.805	0.828	0.859	0.883	0.943
13	0.814	0.837	0.866	0.889	0.945
14	0.825	0.846	0.874	0.895	0.947
15	0.835	0.855	0.881	0.901	0.950
16	0.844	0.863	0.887	0.906	0.952
17	0.851	0.869	0.892	0.910	0.954
18	0.858	0.874	0.897	0.914	0.956
19	0.863	0.879	0.901	0.917	0.957
20	0.868	0.884	0.905	0.920	0.959
21	0.873	0.888	0.908	0.923	0.960
22	0.878	0.892	0.911	0.926	0.961
23	0.881	0.895	0.914	0.928	0.962
24	0.884	0.898	0.916	0.930	0.963
25	0.886	0.901	0.918	0.931	0.964
26	0.891	0.904	0.920	0.933	0.965
27	0.894	0.906	0.923	0.935	0.965
28	0.896	0.908	0.924	0.936	0.966
29	0.898	0.910	0.926	0.937	0.966
30	0.900	0.912	0.927	0.939	0.967
31	0.902	0.914	0.929	0.940	0.967
32	0.904	0.915	0.930	0.941	0.968
33	0.906	0.917	0.931	0.942	0.968
34	0.908	0.919	0.933	0.943	0.969
35	0.910	0.920	0.934	0.944	0.969
36	0.912	0.922	0.935	0.945	0.970
37	0.914	0.924	0.936	0.946	0.970
38	0.916	0.925	0.938	0.947	0.971
39	0.917	0.927	0.939	0.948	0.971
40	0.919	0.928	0.940	0.949	0.972
41	0.920	0.929	0.941	0.950	0.972
42	0.922	0.930	0.942	0.951	0.972
43	0.923	0.932	0.943	0.951	0.973
44	0.924	0.933	0.944	0.952	0.973
45	0.926	0.934	0.945	0.953	0.973
46	0.927	0.935	0.945	0.953	0.974
47	0.928	0.936	0.946	0.954	0.974
48	0.929	0.937	0.947	0.954	0.974
49	0.929	0.937	0.947	0.955	0.974
50	0.930	0.938	0.947	0.955	0.974

(From Gilbert, 1987)

TABLE 3-4

ONE-SIDED CONFIDENCE LIMIT VALUES

Degrees of Freedom	$t_{0.60}$	$t_{0.70}$	$t_{0.80}$	$t_{0.90}$	$t_{0.95}$	$t_{0.975}$	$t_{0.990}$	$t_{0.995}$
1	.325	.727	1.376	3.078	6.314	12.706	31.821	63.657
2	.289	.617	1.061	1.886	2.920	4.303	6.965	9.925
3	.277	.584	.978	1.638	2.353	3.182	4.541	5.841
4	.271	.569	.941	1.533	2.132	2.776	3.747	4.604
5	.267	.559	.920	1.476	2.015	2.571	3.365	4.032
6	.265	.553	.906	1.440	1.943	2.447	3.143	3.707
7	.263	.549	.896	1.415	1.895	2.365	2.998	3.499
8	.262	.546	.889	1.397	1.860	2.306	2.896	3.355
9	.261	.543	.883	1.383	1.833	2.262	2.821	3.250
10	.260	.542	.879	1.372	1.812	2.228	2.764	3.169
11	.260	.540	.876	1.363	1.796	2.201	2.718	3.106
12	.259	.539	.873	1.356	1.782	2.179	2.681	3.055
13	.259	.538	.870	1.350	1.771	2.160	2.650	3.012
14	.258	.537	.868	1.345	1.761	2.145	2.624	2.977
15	.258	.536	.866	1.341	1.753	2.131	2.602	2.947
16	.258	.535	.865	1.337	1.746	2.120	2.583	2.921
17	.257	.534	.863	1.333	1.740	2.110	2.567	2.898
18	.257	.534	.862	1.330	1.734	2.101	2.552	2.878
19	.257	.533	.861	1.328	1.729	2.093	2.539	2.861
20	.257	.533	.860	1.325	1.725	2.086	2.528	2.845
21	.257	.532	.859	1.323	1.721	2.080	2.518	2.831
22	.256	.532	.858	1.321	1.717	2.074	2.508	2.819
23	.256	.532	.858	1.319	1.714	2.069	2.500	2.807
24	.256	.531	.857	1.318	1.711	2.064	2.492	2.797
25	.256	.531	.856	1.316	1.708	2.060	2.485	2.787
26	.256	.531	.856	1.315	1.706	2.056	2.479	2.779
27	.256	.531	.855	1.314	1.703	2.052	2.473	2.771
28	.256	.530	.855	1.313	1.701	2.048	2.467	2.763
29	.256	.530	.854	1.311	1.699	2.045	2.462	2.756
30	.256	.530	.854	1.310	1.697	2.042	2.457	2.750
40	.255	.529	.851	1.303	1.684	2.021	2.423	2.704
60	.254	.527	.848	1.296	1.671	2.000	2.390	2.660
120	.254	.526	.845	1.289	1.658	1.980	2.358	2.617
∞	.253	.524	.842	1.282	1.645	1.960	2.326	2.576

(From Gilbert, 1987)

TABLE 3-5

VALUES OF $H_{1-\alpha} = H_{0.95}$ FOR COMPUTING A ONE-SIDED UPPER 95 PERCENT
CONFIDENCE LIMIT ON A LOGNORMAL MEAN

s_y	n									
	3	5	7	10	12	15	21	31	51	101
0.10	2.750	2.035	1.886	1.802	1.775	1.749	1.722	1.701	1.684	1.670
0.20	3.295	2.198	1.992	1.881	1.843	1.809	1.771	1.742	1.718	1.697
0.30	4.109	2.402	2.125	1.977	1.927	1.882	1.833	1.793	1.761	1.733
0.40	5.220	2.651	2.282	2.089	2.026	1.968	1.905	1.856	1.813	1.777
0.50	6.495	2.947	2.465	2.220	2.141	2.068	1.989	1.928	1.876	1.830
0.60	7.807	3.287	2.673	2.368	2.271	2.181	2.085	2.010	1.946	1.891
0.70	9.120	3.662	2.904	2.532	2.414	2.306	2.191	2.102	2.025	1.960
0.80	10.43	4.062	3.155	2.710	2.570	2.443	2.307	2.202	2.112	2.035
0.90	11.74	4.478	3.420	2.902	2.738	2.589	2.432	2.310	2.206	2.117
1.00	13.05	4.905	3.696	3.103	2.915	2.744	2.564	2.423	2.306	2.205
1.25	16.33	6.001	4.426	3.639	3.389	3.163	2.923	2.737	2.580	2.447
1.50	19.60	7.120	5.184	4.207	3.896	3.612	3.311	3.077	2.881	2.713
1.75	22.87	8.250	5.960	4.795	4.422	4.081	3.719	3.437	3.200	2.997
2.00	26.14	9.387	6.747	5.396	4.962	4.564	4.141	3.812	3.533	3.295
2.50	32.69	11.67	8.339	6.621	6.067	5.557	5.013	4.588	4.228	3.920
3.00	39.23	13.97	9.945	7.864	7.191	6.570	5.907	5.388	4.947	4.569
3.50	45.77	16.27	11.56	9.118	8.326	7.596	6.815	6.201	5.681	5.233
4.00	52.31	18.58	13.18	10.38	9.469	8.630	7.731	7.024	6.424	5.908
4.50	58.85	20.88	14.80	11.64	10.62	9.669	8.652	7.854	7.174	6.590
5.00	65.39	23.19	16.43	12.91	11.77	10.71	9.579	8.688	7.929	7.277
6.00	78.47	27.81	19.68	15.45	14.08	12.81	11.44	10.36	9.449	8.661
7.00	91.55	32.43	22.94	18.00	16.39	14.90	13.31	12.05	10.98	10.05
8.00	104.6	37.06	26.20	20.55	18.71	17.01	15.18	13.74	12.51	11.45
9.00	117.7	41.68	29.46	23.10	21.03	19.11	17.05	15.43	14.05	12.85
10.00	130.8	46.31	32.73	25.66	23.35	21.22	18.93	17.13	15.59	14.26

(From Gilbert, 1987)

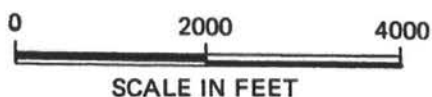
TABLE 3-6

VALUES OF λ FOR ESTIMATING THE MEAN AND VARIANCE OF A
NORMAL DISTRIBUTION USING A SINGLY CENSORED DATA SET

$\gamma \backslash h$	h												h
	.01	.02	.03	.04	.05	.06	.07	.08	.09	.10	.15	.20	
.00	.010100	.020400	.030902	.041583	.052507	.063627	.074953	.086488	.09824	.11020	.17342	.24268	.
.05	.010551	.021294	.032225	.043350	.054670	.066189	.077909	.089834	.10197	.11431	.17935	.25033	.
.10	.010950	.022082	.033398	.044902	.056596	.068483	.080568	.092852	.10534	.11804	.18479	.25741	.
.15	.011310	.022798	.034466	.046318	.058356	.070586	.083009	.095629	.10845	.12148	.18985	.26405	.
.20	.011642	.023459	.035453	.047629	.059990	.072539	.085280	.098216	.11135	.12469	.19460	.27031	.
.25	.011952	.024076	.036377	.048858	.061522	.074372	.087413	.10065	.11408	.12772	.19910	.27626	.
.30	.012243	.024658	.037249	.050018	.062969	.076106	.089433	.10295	.11667	.13059	.20338	.28193	.
.35	.012520	.025211	.038077	.051120	.064345	.077756	.091355	.10515	.11914	.13333	.20747	.28737	.
.40	.012784	.025738	.038866	.052173	.065660	.079332	.093193	.10725	.12150	.13595	.21139	.29260	.
.45	.013036	.026243	.039624	.053182	.066921	.080845	.094958	.10926	.12377	.13847	.21517	.29765	.
.50	.013279	.026728	.040352	.054153	.068135	.082301	.096657	.11121	.12595	.14090	.21882	.30253	.
.55	.013513	.027196	.041054	.055089	.069306	.083708	.098298	.11308	.12806	.14325	.22235	.30725	.
.60	.013739	.027649	.041733	.055995	.070439	.085068	.099887	.11490	.13011	.14552	.22578	.31184	.
.65	.013958	.028087	.042391	.056874	.071538	.086388	.10143	.11666	.13209	.14773	.22910	.31630	.
.70	.014171	.028513	.043030	.057726	.072605	.087670	.10292	.11837	.13402	.14987	.23234	.32065	.
.75	.014378	.028927	.043652	.058556	.073643	.088917	.10438	.12004	.13590	.15196	.23550	.32489	.
.80	.014579	.029330	.044258	.059364	.074655	.090133	.10580	.12167	.13773	.15400	.23858	.32903	.
.85	.014775	.029723	.044848	.060153	.075642	.091319	.10719	.12325	.13952	.15599	.24158	.33307	.
.90	.014967	.030107	.045425	.060923	.076606	.092477	.10854	.12480	.14126	.15793	.24452	.33703	.
.95	.015154	.030483	.045989	.061676	.077549	.093611	.10987	.12632	.14297	.15983	.24740	.34091	.
1.00	.015338	.030850	.046540	.062413	.078471	.094720	.11116	.12780	.14465	.16170	.25022	.34471	1.

$\gamma \backslash h$	h												h
	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.80	.90	
.00	.31862	.4021	.4941	.5961	.7096	.8368	.9808	1.145	1.336	1.561	2.176	3.283	.
.05	.32793	.4130	.5066	.6101	.7252	.8540	.9994	1.166	1.358	1.585	2.203	3.314	.
.10	.33662	.4233	.5184	.6234	.7400	.8703	1.017	1.185	1.379	1.608	2.229	3.345	.
.15	.34480	.4330	.5296	.6361	.7542	.8860	1.035	1.204	1.400	1.630	2.255	3.376	.
.20	.35255	.4422	.5403	.6483	.7678	.9012	1.051	1.222	1.419	1.651	2.280	3.405	.
.25	.35993	.4510	.5506	.6600	.7810	.9158	1.067	1.240	1.439	1.672	2.305	3.435	.
.30	.36700	.4595	.5604	.6713	.7937	.9300	1.083	1.257	1.457	1.693	2.329	3.464	.
.35	.37379	.4676	.5699	.6821	.8060	.9437	1.098	1.274	1.476	1.713	2.353	3.492	.
.40	.38033	.4755	.5791	.6927	.8169	.9570	1.113	1.290	1.494	1.732	2.376	3.520	.
.45	.38665	.4831	.5880	.7029	.8295	.9700	1.127	1.306	1.511	1.751	2.399	3.547	.
.50	.39276	.4904	.5967	.7129	.8408	.9826	1.141	1.321	1.528	1.770	2.421	3.575	.
.55	.39870	.4976	.6051	.7225	.8517	.9950	1.155	1.337	1.545	1.788	2.443	3.601	.
.60	.40447	.5045	.6133	.7320	.8625	1.007	1.169	1.351	1.561	1.806	2.465	3.628	.
.65	.41008	.5114	.6213	.7412	.8729	1.019	1.182	1.366	1.557	1.824	2.486	3.654	.
.70	.41555	.5180	.6291	.7502	.8832	1.030	1.195	1.380	1.593	1.841	2.507	3.679	.
.75	.42090	.5245	.6367	.7590	.8932	1.042	1.207	1.394	1.608	1.858	2.528	3.705	.
.80	.42612	.5308	.6441	.7676	.9031	1.053	1.220	1.408	1.624	1.875	2.548	3.730	.
.85	.43122	.5370	.6515	.7761	.9127	1.064	1.232	1.422	1.639	1.892	2.568	3.754	.
.90	.43622	.5430	.6586	.7844	.9222	1.074	1.244	1.435	1.653	1.908	2.588	3.779	.
.95	.44112	.5490	.6656	.7925	.9314	1.085	1.255	1.448	1.668	1.924	2.607	3.803	.
1.00	.44592	.5548	.6724	.8005	.9406	1.095	1.267	1.461	1.682	1.940	2.626	3.827	1.

FIGURES



Bechtel
SAN FRANCISCO

GENERAL ELECTRIC/SPOKANE

SITE LOCATION MAP



Job Number

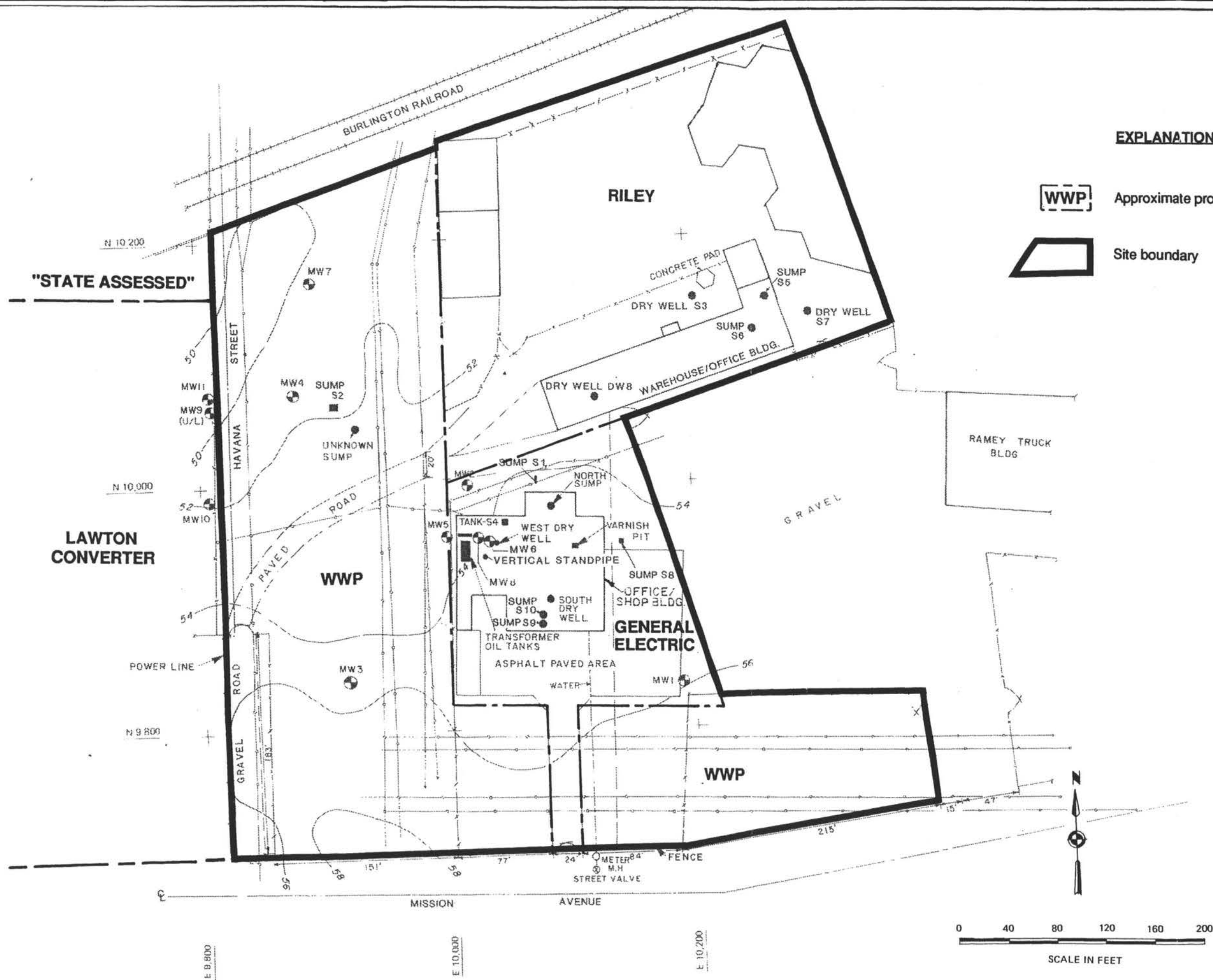
19099

Drawing No.

FIGURE 1-1

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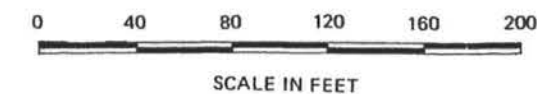
EXPLANATION



Approximate property boundary and owners



Site boundary



BECHTEL
SAN FRANCISCO

GENERAL ELECTRIC/SPOKANE

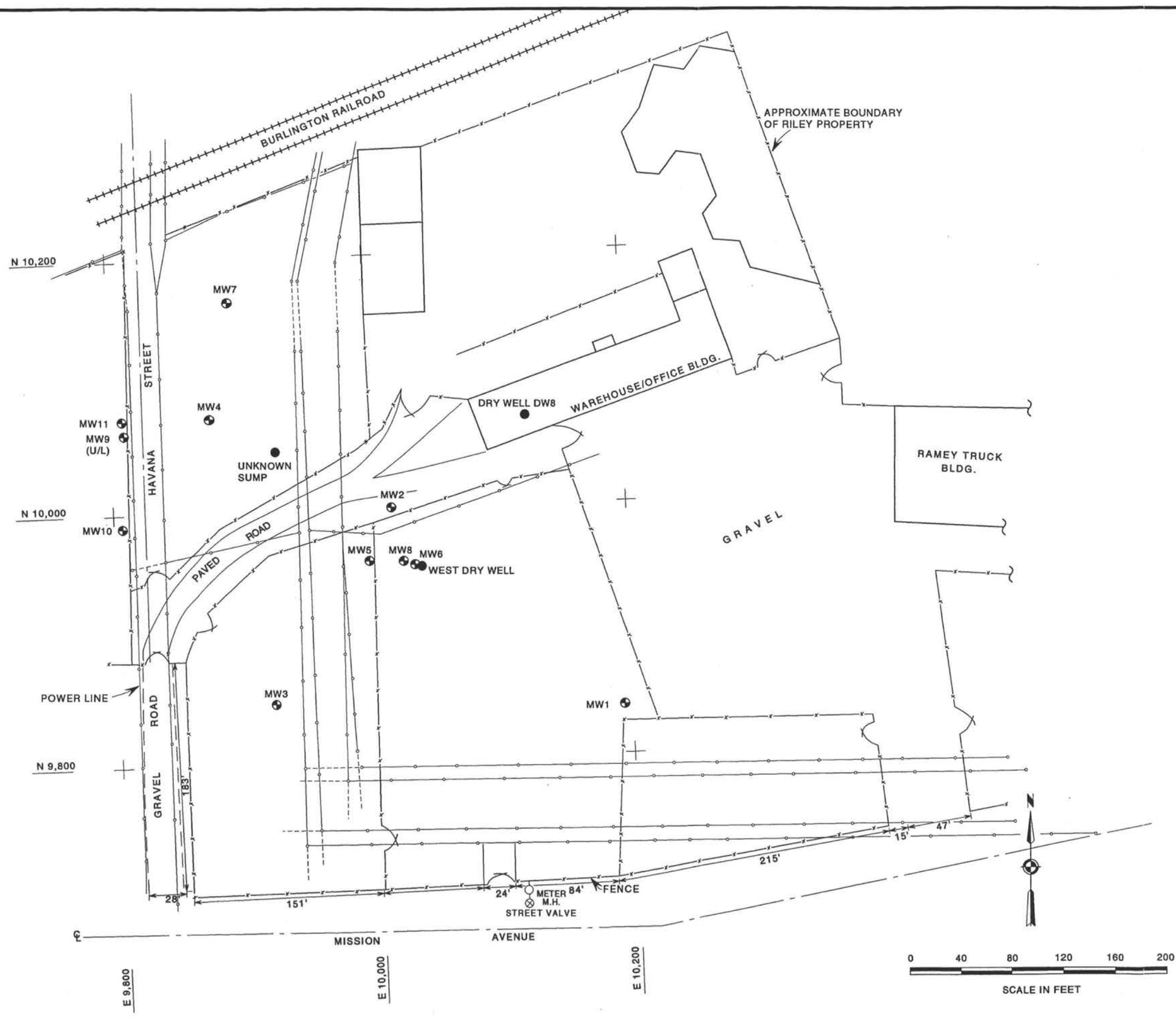
**SITE OWNERSHIP AND
FORMER FACILITIES**



JOB No.
19099

DRAWING No.
FIGURE 1-2

REV.
B



Bechtel SAN FRANCISCO		
GENERAL ELECTRIC/SPOKANE		
EXISTING SITE FEATURES		
Job Number	Drawing No.	Rev.
19099	FIGURE 1-3	A

WORKSHEETS

WORK SHEET 1

AREA ACCEPTANCE CALCULATIONS FOR SOIL PCB DATA

Area: _____

Step 1 - List the concentration and the associated sample number for each verification sample taken in the area. Do not perform the calculations for area acceptance unless all sample values are less than 2 times the cleanup level and no more than 10 percent of the values is greater than the cleanup level. Use a value equal to 1/2 the detection limit for concentrations less than the detection limit. Use a value equal to the method detection limit for measurements above the detection limit but below the practical quantitation limit.

Sample # / Conc.	Sample # / Conc.	Sample # / Conc.	Sample # / Conc.
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____

Step 2 - Calculate the mean of the verification sample results for all the samples taken in the area using the actual number of samples taken(n).

$$\bar{x} = \frac{\sum X}{n} = \underline{\hspace{2cm}}$$

Step 3 - Calculate the standard deviation of the verification sample results for all the samples taken in the area.

$$S = \sqrt{\frac{\sum (\bar{x} - X)^2}{n-1}} = \underline{\hspace{2cm}}$$

Step 4 - Calculate "τ" of the verification sample results for the area.

$$\tau = \frac{(10 - \bar{x})}{S} = \underline{\hspace{2cm}} \text{ for depth } \leq 15 \text{ feet}$$

$$\tau = \frac{(60 - \bar{x})}{S} = \underline{\hspace{2cm}} \text{ for depth } > 15 \text{ feet}$$

Step 5 - Use the following formula to calculate the required number of samples. Compare the calculated number of sample with the actual number taken. A minimum of five (5) samples per area is required.

$$n_d = \frac{(Z_{1-\beta} + Z_{1-\alpha})^2}{\tau^2} \quad \text{Where: } Z_{1-\beta} = 0.842 \text{ and } Z_{1-\alpha} = 1.645$$

$$\text{Number of Samples (Calculated)} \quad n_d = \underline{\hspace{1cm}} \leq \underline{\hspace{1cm}} = n \text{ (Actual)}$$

Where:

n = Number of samples for the area.

X = Sample result.

\bar{x} = Mean sample result for the area.

S = Standard deviation of sample results for the area.

n_d = Required number of samples to obtain needed statistical confidence.

WORK SHEET 1 (cont.)
AREA ACCEPTANCE CALCULATIONS FOR SOIL PCB DATA

Area: _____

Step 6 - Using the calculated values for \bar{x} and S above and the degrees of freedom (df), which is one less than the number of samples (n-1) and $1 - \alpha = 0.95$, find the value of t from Table 3-1.

Step 7 - Using the values of \bar{x} , S, and t, calculate the upper confidence limit (UCL) on the mean at a 95 percent confidence using the following formula:

$$UCL = \bar{x} + t_{1 - \alpha, n - 1} \frac{S}{\sqrt{n}} = \underline{\hspace{2cm}}$$

Step 8 - Compare the UCL calculated with the appropriate cleanup level for PCBs at a given depth.

At Depths at or above 15 ft.

UCL \leq 10 mg/kg ☐ Pass

UCL $>$ 10 mg/kg ☐ Fail

At Depths below 15 ft.

UCL \leq 60 mg/kg ☐ Pass

UCL $>$ 60 mg/kg ☐ Fail

Prepared by/Date _____ Checked by/Date _____

Where:

n = Number of samples for the area.

\bar{x} = Mean sample result for the area.

n_d = Required number of samples to obtain needed statistical confidence.

X = Sample result.

S = Standard deviation of sample results for the area.

WORK SHEET 2 AREA ACCEPTANCE CALCULATIONS FOR SOIL TPH DATA

Area: _____

Step 1 - List the concentration and the associated sample number for each verification sample taken in the area. Do not perform the calculations for area acceptance unless all sample values are less than 2 times the cleanup level and no more than 10 percent of the values is greater than the cleanup level. Use a value equal to 1/2 the detection limit for concentrations less than the detection limit. Use a value equal to the method detection limit for measurements above the detection limit but below the practical quantitation limit.

Sample # / Conc.	Sample # / Conc.	Sample # / Conc.	Sample # / Conc.
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____

Step 2 - Calculate the mean of the verification sample results for all the samples taken in the area and listed above using the actual number of samples taken(n).

$$\bar{x} = \frac{\sum X}{n} = \underline{\hspace{2cm}}$$

Step 3 - Calculate the standard deviation of the verification sample results for all the samples taken in the area, listed above, and included in the calculation of the mean.

$$S = \sqrt{\frac{\sum (\bar{x} - X)^2}{n-1}} = \underline{\hspace{2cm}}$$

Step 4 - Calculate "τ" of the verification sample results for the area.

$$\tau = \frac{(200 - \bar{x})}{S} = \underline{\hspace{2cm}}$$

Step 5 - Use the following formula to calculate the required number of samples. Compare the calculated number of sample with the actual number taken. A minimum of five (5) samples per area is required.

$$n_d = \frac{(Z_{1-\beta} + Z_{1-\alpha})^2}{\tau^2} \quad \text{Where: } Z_{1-\beta} = 0.842 \text{ and } Z_{1-\alpha} = 1.645$$

Number of Samples (Calculated) $n_d = \underline{\hspace{1cm}} \leq \underline{\hspace{1cm}} = n$ (Actual)

Where:

n = Number of samples for the area.

\bar{x} = Mean sample result for the area.

n_d = Required number of samples to obtain needed statistical confidence.

X = Sample result.

S = Standard deviation of sample results for the area.

WORK SHEET 2 (cont.)
AREA ACCEPTANCE CALCULATIONS FOR SOIL TPH DATA

Area: _____

Step 6 - Using the calculated values for \bar{x} and S above and the degrees of freedom (df), which is one less than the number of samples ($n-1$) and $1 - \alpha = 0.95$, find the value of t from Table 3-1.

Step 7 - Using the values of \bar{x} , S , and t , calculate the upper confidence limit (UCL) on the mean at a 95 percent confidence using the following formula:

$$UCL = \bar{x} + t_{1-\alpha, n-1} \frac{S}{\sqrt{n}} = \underline{\hspace{2cm}}$$

Step 8 - Compare the UCL calculated with the appropriate cleanup level for PCBs at a given depth.

UCL \leq 200 mg/kg

☐ Pass

UCL $>$ 200 mg/kg

☐ Fail

Prepared by/Date _____ Checked by/Date _____

Where:

n = Number of samples for the area.

\bar{x} = Mean sample result.

\bar{x} = Mean sample result for the area.

S = Standard deviation of sample results for the area.

n_d = Required number of samples to obtain needed statistical confidence.

WORK SHEET 3
FINAL ACCEPTANCE CALCULATIONS FOR NORMALLY DISTRIBUTED
SOIL PCB DATA

Area: _____

Step 1 - List the concentration and the associated sample number for each verification and confirmation sample taken in the area. The concentration used for confirmation samples should be the sum of the Aroclors detected. Do not perform the calculations for area acceptance unless all sample values are less than 2 times the cleanup level and no more than 10 percent of the values is greater than the cleanup level. Use a value equal to 1/2 the detection limit for concentrations less than the detection limit. Use a value equal to the method detection limit for measurements above the detection limit but below the practical quantitation limit.

Sample # / Conc.	Sample # / Conc.	Sample # / Conc.	Sample # / Conc.
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____

Step 2 - Calculate the mean of the sample results for all the verification and confirmation samples taken in the area using the actual number of samples taken(n).

$$\bar{x} = \frac{\sum X}{n} = \underline{\hspace{2cm}}$$

Step 3 - Calculate the standard deviation of the sample results for all the verification and confirmation samples taken in the area.

$$S = \sqrt{\frac{\sum (\bar{x} - X)^2}{n-1}} = \underline{\hspace{2cm}}$$

Step 4 - Find the value of t from Table 3-1 using a 95 percent confidence interval and the degrees of freedom (df), which is one less than the number of samples (n-1).

Step 5 - Using the values of \bar{x} , S, and t, calculate the upper confidence limit (UCL) on the mean at a 95 percent confidence using the following formula:

$$UCL = \bar{x} + t_{1-\alpha, n-1} \frac{S}{\sqrt{n}} = \underline{\hspace{2cm}}$$

Step 6 - Compare the UCL calculated with the appropriate cleanup level for PCBs at a given depth.

At Depths at or above 15 ft.

UCL ≤ 10 mg/kg ☐ Pass

UCL > 10 mg/kg ☐ Fail

At Depths below 15 ft.

UCL ≤ 60 mg/kg ☐ Pass

UCL > 60 mg/kg ☐ Fail

Prepared by/Date _____ Checked by/Date _____

<p>Where:</p> <p>n = Number of samples for the area.</p> <p>\bar{x} = Mean sample result for the area.</p> <p>n_d = Required number of samples to obtain needed statistical confidence.</p>	<p>X = Sample result.</p> <p>S = Standard deviation of sample results for the area.</p>
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WORK SHEET 4
FINAL ACCEPTANCE CALCULATIONS FOR NORMALLY DISTRIBUTED
SOIL TPH DATA

Area: _____

Step 1 - List the concentration and the associated sample number for each verification and confirmation sample taken in the area. Do not perform the calculations for area acceptance unless all sample values are less than 2 times the cleanup level and no more than 10 percent of the values is greater than the cleanup level. Use a value equal to 1/2 the detection limit for concentrations less than the detection limit. Use a value equal to the method detection limit for measurements above the detection limit but below the practical quantitation limit.

Sample # / Conc.	Sample # / Conc.	Sample # / Conc.	Sample # / Conc.
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____

Step 2 - Calculate the mean of the sample results for all the verification and confirmation samples taken in the area and listed above using the actual number of samples taken(n).

$$\bar{x} = \frac{\sum X}{n} = \underline{\hspace{2cm}}$$

Step 3 - Calculate the standard deviation of the verification and confirmation sample results for all the samples taken in the area, listed above, and included in the calculation of the mean.

$$S = \sqrt{\frac{\sum (\bar{x} - X)^2}{n-1}} = \underline{\hspace{2cm}}$$

Step 4 - Find the value of t from Table 3-1 using a 95 percent confidence interval and the degrees of freedom (df), which is one less than the number of samples (n-1).

Step 5 - Using the values of \bar{x} , S, and t, calculate the upper confidence limit on the mean at a 95 percent confidence using the following formula:

$$UCL = \bar{x} + t_{1-\alpha, n-1} \frac{S}{\sqrt{n}} = \underline{\hspace{2cm}}$$

Step 6 - Compare the UCL calculated with the appropriate cleanup level for TPH.

UCL ≤ 200 mg/kg	<input type="checkbox"/> Pass
UCL > 200 mg/kg	<input type="checkbox"/> Fail

Prepared by/Date _____ Checked by/Date _____

Where:

n = Number of samples for the area.	X = Sample result.
\bar{x} = Mean sample result for the area.	S = Standard deviation of sample results for the area.
n_d = Required number of samples to obtain needed statistical confidence.	

WORK SHEET 5
FINAL ACCEPTANCE CALCULATIONS
FOR LOGNORMALLY DISTRIBUTED SOIL PCB DATA

Area: _____

Step 1 - List the concentration and the associated sample number for each verification and confirmation sample taken in the area listed above. The concentration used for confirmation samples should be the sum of the Aroclors detected. Transform all sample concentrations, natural log (\log_e). Do not perform the calculations for area acceptance unless all sample values are less than 2 times the cleanup level and no more than 10 percent of the values is greater than the cleanup level.

Use a value equal to 1/2 the detection limit for concentrations less than the detection limit. Use a value equal to the method detection limit for measurements above the detection limit but below the practical quantitation limit.

Sample # / Conc.	Sample # / Conc.	Sample # / Conc.	Sample # / Conc.
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____

Step 2 - Calculate the mean of the \log_e transformed sample results for all the verification and confirmation samples taken in the area using the actual number of samples taken (n).

$$\bar{y} = \frac{\sum Y}{n} = \underline{\hspace{2cm}}$$

Step 3 - Calculate the standard deviation of the sample results for all the verification and confirmation samples taken in the area.

$$S_y = \sqrt{\frac{\sum (\bar{y} - Y)^2}{n-1}} = \underline{\hspace{2cm}}$$

Step 4 - Using the calculated values of \bar{y} and S_y , find the value of H from Table 3-4.

Step 5 - Using the values of \bar{y} , S_y , and H, calculate for a 95-percent one-sided confidence interval the upper confidence limit (UCL) by using the following formula:

$$UCL = \exp\left(\bar{y} + 0.5S_y^2 + \frac{S_y H_{1-\alpha}}{\sqrt{n-1}}\right) = \underline{\hspace{2cm}}$$

Step 6 - Compare the UCL calculated with the appropriate cleanup level for PCBs at a given depth.

At Depths at or above 15 ft.

UCL \leq 10 mg/kg ☐ Pass

UCL $>$ 10 mg/kg ☐ Fail

At Depths below 15 ft.

UCL \leq 60 mg/kg ☐ Pass

UCL $>$ 60 mg/kg ☐ Fail

Prepared by/Date _____ Checked by/Date _____

Where:

n = Number of samples for the area.

\bar{x} = Mean sample result for the area.

n_d = Required number of samples to obtain needed statistical confidence.

Y = \log_e - transformed sample result.

S = Standard deviation of sample results for the area.

WORK SHEET 6
FINAL ACCEPTANCE CALCULATIONS
FOR LOGNORMALLY DISTRIBUTED SOIL TPH DATA

Area: _____

Step 1 - List the concentration and the associated sample number for each verification and confirmation sample taken in the area listed above. Transform all sample concentrations, natural log (\log_e). Do not perform the calculations for area acceptance unless all sample values are less than 2 times the cleanup level and no more than 10 percent of the values is greater than the cleanup level.

Use a value equal to 1/2 the detection limit for concentrations less than the detection limit. Use a value equal to the method detection limit for measurements above the detection limit but below the practical quantitation limit.

Sample # / Conc.	Sample # / Conc.	Sample # / Conc.	Sample # / Conc.
____ / ____	____ / ____	____ / ____	____ / ____
____ / ____	____ / ____	____ / ____	____ / ____
____ / ____	____ / ____	____ / ____	____ / ____
____ / ____	____ / ____	____ / ____	____ / ____
____ / ____	____ / ____	____ / ____	____ / ____

Step 2 - Calculate the mean of the \log_e transformed sample results for all the verification and confirmation samples taken in the area using the actual number of samples taken(n).

$$\bar{y} = \frac{\sum Y}{n} = \underline{\hspace{2cm}}$$

Step 3 - Calculate the standard deviation of the sample results for all the verification and confirmation samples taken in the area.

$$S_y = \sqrt{\frac{\sum (\bar{y} - Y)^2}{n-1}} = \underline{\hspace{2cm}}$$

Step 4 - Using the calculated values of \bar{y} and S_y , find the value of $H_{1-\alpha}$ from Table 3-4 for $1 - \alpha = 0.95$.

Step 5 - Using the values of \bar{y} , S_y , and $H_{1-\alpha}$ calculate for a 95-percent one-sided confidence interval the upper confidence limit (UCL) by using the following formula:

$$UCL = \exp\left(\bar{y} + 0.5S_y + \frac{S_y H_{1-\alpha}}{\sqrt{n-1}}\right) = \underline{\hspace{2cm}}$$

Step 6 - Compare the UCL calculated with the appropriate cleanup level for TPH.

UCL \leq 200 mg/kg

☐ Pass

UCL $>$ 200 mg/kg

☐ Fail

Prepared by/Date _____ Checked by/Date _____

Where:

n = Number of samples for the area.

Y = \log_e - transformed sample result.

\bar{x} = Mean sample result for the area.

S_y = Standard deviation of sample results for the area.

$H_{1-\alpha}$ = Value from Table 3-4, based on one-sided α of 0.05.

WORK SHEET 7
COMPLIANCE MONITORING CALCULATIONS
FOR NORMALLY DISTRIBUTED GROUND-WATER PCB DATA

Monitoring Well: _____

- Step 1 - List the concentration and the associated sample number for each sample taken from the monitoring well listed above. The concentration used should be the sum of the Aroclors detected. A minimum of 8 samples is required. Do not perform the calculations for acceptance unless all sample values are less than 2 times the cleanup level and no more than 10 percent of the values is greater than the cleanup level.

Use a value equal to 1/2 the detection limit for concentrations less than the detection limit. Use a value equal to the method detection limit for measurements above the detection limit but below the practical quantitation limit.

Sample # / Conc.	Sample # / Conc.	Sample # / Conc.	Sample # / Conc.
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____
_____ / _____	_____ / _____	_____ / _____	_____ / _____

- Step 2 - Calculate the mean of the sample results for all the samples taken from the monitoring well using the actual number of samples taken(n).

$$\bar{x} = \frac{\sum X}{n} = \underline{\hspace{2cm}}$$

- Step 3 - Calculate the standard deviation of the sample results for all the samples taken from the monitoring well, listed above, and included in the calculation of the mean.

$$S = \sqrt{\frac{\sum (\bar{x} - X)^2}{n-1}} = \underline{\hspace{2cm}}$$

- Step 4 - Using the calculated values of \bar{x} and S , and the degrees of freedom (df) which is one less than the number of samples (n - 1) find the value of t from Table 3-1, for $1 - \alpha = 0.95$.

- Step 5 - Using the values of \bar{x} , S , and t, calculate for a 95-percent one-sided confidence interval the upper confidence limit (UCL) by using the following formula;

$$UCL = \bar{x} + t_{1-\alpha, n-1} \frac{S}{\sqrt{n}} = \underline{\hspace{2cm}}$$

- Step 6 - Compare the UCL calculated to the cleanup level of 0.01 $\mu\text{g/l}$ for PCBs in ground water.

UCL \leq 0.01 $\mu\text{g/l}$ ☐ Pass UCL $>$ 0.01 $\mu\text{g/l}$ ☐ Fail

Prepared by/Date _____ Checked by/Date _____

Where:

n = Number of samples for each sampling round.
 \bar{x} = Mean sample data for the sampling round
 t = Value of the t parameter from Table 3-1, based on a one-sided α of 0.05 and $n-1$ degrees of freedom.

X = Sample result.
 S = Standard deviation of sample data for the sampling round.
 df = Degrees of freedom.

WORK SHEET 8
COMPLIANCE MONITORING CALCULATIONS
FOR LOGNORMALLY DISTRIBUTED GROUND-WATER PCB DATA

Monitoring Well: _____

- Step 1 - List the concentration and the associated sample number for each sample taken from the monitoring well listed above. The concentration used should be the sum of the Aroclors detected. Transform all sample concentrations, natural log (\log_e). A minimum of 8 samples is required. Do not perform the calculations for acceptance unless all sample values are less than 2 times the cleanup level and no more than 10 percent of the values is greater than the cleanup level.

Use a value equal to 1/2 the detection limit for concentrations less than the detection limit. Use a value equal to the method detection limit for measurements above the detection limit but below the practical quantitation limit.

Sample # / Conc.	Sample # / Conc.	Sample # / Conc.	Sample # / Conc.
____ / ____	____ / ____	____ / ____	____ / ____
____ / ____	____ / ____	____ / ____	____ / ____
____ / ____	____ / ____	____ / ____	____ / ____
____ / ____	____ / ____	____ / ____	____ / ____
____ / ____	____ / ____	____ / ____	____ / ____

- Step 2 - Calculate the mean of the \log_e transformed sample results for all the samples taken from the monitoring well using the actual number of samples taken (n).

$$\bar{y} = \frac{\sum Y}{n} = \underline{\hspace{2cm}}$$

- Step 3 - Calculate the standard deviation of the sample results for all the samples taken from the monitoring well.

$$S_y = \sqrt{\frac{\sum (\bar{y} - Y)^2}{n-1}} = \underline{\hspace{2cm}}$$

- Step 4 - Using the calculated values of \bar{y} and S_y , find the value of $H_{1-\alpha}$ from Table 3-4, for $1-\alpha = 0.95$.

- Step 5 - Using the values of \bar{y} , S_y , and $H_{1-\alpha}$ calculate for a 95-percent one-sided confidence interval the upper confidence limit (UCL) by using the following formula;

$$UCL = \exp\left(\bar{y} + 0.5s_y^2 + \frac{s_y H_{1-\alpha}}{\sqrt{n-1}}\right) = \underline{\hspace{2cm}}$$

- Step 6 - Compare the UCL calculated to the cleanup level of 0.01 $\mu\text{g/l}$ for PCBs in ground water.

$$\begin{array}{ll} UCL \leq 0.01 \mu\text{g/l} & \text{o Pass} \\ UCL > 0.01 \mu\text{g/l} & \text{o Fail} \end{array}$$

Prepared by/Date _____ Checked by/Date _____

Where:

n = Number of samples for each sampling round.
 \bar{y} = Mean \log_e - transformed data for the sampling round.
 $H_{1-\alpha}$ = Value from Table 3-4, based on one-sided α of 0.05.

Y = \log_e - transformed sample result.
 S = Standard deviation of \log_e - transformed data for the sampling round.